Adoption of Blockchain in SAP Supply Chain Management

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Abstract -

Companies now face a more challenging competitive environment because of today's markets' increasingly volatile and demanding nature. Collaboration, integration, flexibility, and trust among stakeholders have become critical for supply chains to thrive in this dynamic and unpredictable world. On top of that, supply chain management is widely acknowledged as an essential corporate technique for reducing costs and boosting productivity in the modern global economy. However, it is necessary to update supply chain management techniques in light of emerging problems such as supply chain complexity. The importance of new technology applications in supply chains has grown as a consequence of the efforts of businesses to create information technologies for the optimization of supply chain activities. A specialized technology application is required to regulate the supply chain flow effectively. In this situation, blockchain looks to overcome the issues above due to its excellent technological capabilities. Blockchain adoption may increase supply chain security, traceability, and efficiency. There are integrated levels of data management and protection through blockchain technology. It creates an immutable ledger of data with great capabilities of recording any information. The distributed ledger provides resilience as it is resistant to tampering. As a bonus, blockchain technology can enhance coordination and communication across parties, leading to efficiencies and cost savings. Blockchain also boosts customer confidence since it allows the tracking of goods and services across all levels of the supply chain. This paper studies the adoption of blockchain in SAP supply chain management.

Key Words: Blockchain; Supply Chain; Supply Chain Management; SAP

1.INTRODUCTION

SAP refers to the System Applications and Products in Data Processing system. Wellenreuther, Hopp, Hector, Plattner, and Tschira established SAP Software in 1972; the company is now a European multinational (SAP, 2022). Over the years, SAP has become a leading multinational software solutions provider. The Multinational established various techniques for managing business operations and enhancing customer relations. SAP system is complete with multiple modules covering every business aspect. One of the most critical aspects of business operations is the supply chain. The term "supply chain" refers to the group of people and organizations engaged in making and distributing a product to the end user (Singh et al., 2022). The supply chain starts with the raw materials and ends with the person who receives the finished product. Supply chain management thus refers to the management of the flow of goods and services in an organization from the time they transform from raw materials upto finished products. Companies can save money and improve delivery times by coordinating their supply chains.

In recent years, supply chain management has been sophisticated owing to the dynamic nature of business operations (Mukri, 2018). Most uncertainties happen with great emergencies making many businesses lose their customers and value. For example, from early 2020, the COVID-19 global pandemic created massive disruptions in most supply chains. New and unforeseen challenges continue to emerge, reducing productivity and profits. The challenges cause most organizations and service providers to reorganize and rebuild their strategic inputs in the supply chain. Several technologies emerged that enhanced traditional supply chain approaches. However, the difficulty is in adopting these systems/services throughout an organization's preexisting supply chain, even though they are designed to make procedures more efficient and cost-effective in the long term. SAP's stated goal is to design its products with cutting-edge genetic codes and the flexibility to incorporate new technologies as they become available on the market. SAP engineered blockchain adoption and compatibility in its supply chain management solutions. The ability of a supply chain to time makes using blockchain technology immediately applicable and relevant. Information delivered from supply chains about a specific item must be transparent, correct, and genuine.

SAP is now improving its approach to blockchain in supply chain management by collaborating with several companies to build a blockchain-based automated supply chain tracking system (SAP, 2022). The supply chain is usually a complex system of interconnected networks operating behind the scenes while providing goods and services. In order to see the bigger picture in the supply chain, companies need a 360-degree perspective of the complete supply chain, which is difficult for most companies in today's global market. A blockchain investment is a long-term bet. Simply put, it is a prudent expenditure (Ruangkanjanases et al., 2022). The potential for blockchain technology to bring about change is enormous. If you are looking for strategic and technical help on your blockchain journey, enterprise solution providers like SAP are the finest partners to allow the implementation of this technology.

1.1 Blockchain principles and architecture

Blockchain technology has already existed for twelve years. In that period, it has seen such substantial change that it would be impossible to describe every facet of its progression in this article. In addition, information regarding the blockchain, including specifics, is relatively easy to locate. Nevertheless, a few fundamental ideas should be brought up immediately because of their significance. In this part, we will first define terms, then discuss the history of blockchain technology, and then discuss the most important characteristics of blockchain. It is no longer business as usual to manage supply chains because of the ongoing disruption caused by new technology solutions in the logistics industry. The supply chain has historically been subject to a great deal of transformation over the last three decades (Wong et al, 2020). What was once a purely operational logistics function that reported to sales or manufacturing and focused on ensuring the supply of production lines and delivery to customers is now an independent supply chain management function. This change occurred because operational logistics became a function that reports to sales or manufacturing. The following is a list of supply chain principles:

Distributed Database	Each party on a blockchain has access to the entire database and its complete history, i.e., no single party controls the data or the information and every party can verify the records of its transaction partners directly, without an intermediary.
Peer-to-peer Transmission	Communication occurs directly between peers instead through a central node, i.e., each node stores and forwards information to all other nodes.
Transparency with Pseudonymity	Every transaction and its associated value are visible to anyone with access to the system, i.e., each node or user has a unique 30-plus-character alphanumeric address that identifies it. Users can choose to remain anonymous or provide proof of their identity to others when transactions occur between blockchain addresses.
Irreversibility of Records	Once a transaction is entered in the database and the accounts are updated, the records cannot be altered, because they are linked to every transaction record before them. Various computational algorithms and approaches are deployed to ensure that the recording on the database is permanent, chronologically ordered, and available to all other on the network.
Computational Logic	The digital nature of the ledger means that blockchain transactions can be tied to a computational logic and can, in essence, be programmed, i.e., users can set up algorithms and rules and automatically trigger transactions between nodes (e.g., smart contracts).

Figure1 : Principles of blockchain

According to Treiblmaier et al., (2022) blockchain technology may be deployed using a decentralized network design or a centralized cloud-based architecture. Both deployment models have their advantages and disadvantages. The peer-to-peer network communication model is often used by distributed architecture. This paradigm stipulates that all nodes inside the network have comparable responsibilities and privileges. The nodes or peers in the network work together to serve each other's requests even though there is either minimal or no centralized administration. Many well-known software programs, including Bitcoin, the file-sharing apps BitTorrent, Napster, and the chat service Skype use this design.
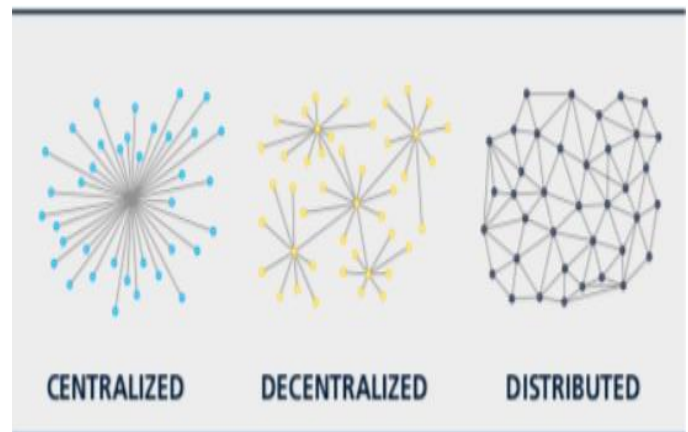

Figure 2 : major types of blockchain.

1.2 SAP and a modern supply chain system

Supply chain management platforms like E2Open and SAP are at the forefront of technology, providing advanced features like near real-time shipment updates and integration with a wide range of ERPs. IBM and Oracle are two other well-known instances of such systems. These cloud-based architectures have a centralized design and often include complex software and hardware. Because of the large volume of traffic and the variety of stakeholders (i.e., small, medium, and large enterprises) that need to be served by a global supply chain system, a centralized design has restrictions regarding scalability and cost (Song et al., 2019). These barriers make it difficult for small and medium-sized firms to enter new and existing markets.
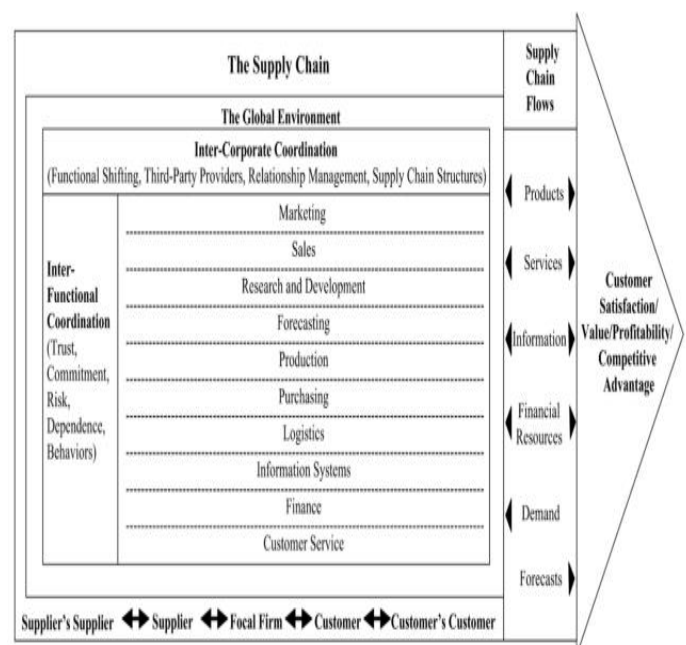

Figure 3 : Supply Chain Process

According to Smith (2020), there are many supply chain mechanisms, even though they are costly, large-scale Enterprise resource planning (ERP) systems. These ERP systems operate on the firm's internal hardware or locally inside the organization in private cloud settings. These data silos hinder interoperability and open standards, cover just a tiny portion of a product's supply chain and make it impossible to track a product's provenance from the beginning with the current system. There are, however, a few notable exceptions. Tally-O is one of these systems, allowing companies to track the source of their fish throughout processing plants. After that, the data is encoded, and then it is printed on the label before being imported once again into the subsequent Tally-O facility.

Technology integration into supply chains will be the primary focus of the industry's most pressing concerns in the supply chain and logistics sector in 2021. The complexity of the information involved in an entire end-to-end network is the primary source of these issues. The flow of information across all of the organizations and levels that make up the whole chain is of utmost significance because the process has four primary aims, which include a reduction in costs, an increase in quality, an increase in flexibility, and a reduction in reaction times. Microsoft Dynamics and SAP are examples of ERP systems.

The capacity of a supply chain to appropriately deal with interruptions has taken on a much greater significance in recent years. Managing supply chain risks is an essential component of contemporary supply chain management. If a company's resilience is appropriately handled, the company's competitive advantage may be protected. In recent years, supply chains have been impacted by various destabilizing occurrences, including natural catastrophes and economic crises, which have posed a significant risk to business operations. The disturbance of a process may result in a ripple effect, which describes an impact that spreads to various entities. The existence of buffers and the rate and amount of recovery both have a role in determining the severity of this effect. The rate of recovery is of utmost significance, as a rapid recovery may ensure continuity and nullify the consequences that will have long-term repercussions (Smith et al., 2021). As a result, disruptive occurrences need supply chains to have a plan of action ready to implement in an emergency. The adoption of recovery measures is often regarded as an essential factor in furthering supply chain resilience.

2. Smart contracts and integration of Blockchain with IoT

In 1994, Szabo was the first person to present the idea of smart contracts to the public. A smart contract is a digital agreement that describes a business transaction and is maintained in a blockchain (Gaynor et al., 2020). Smart contracts may be used to automate and verify commercial transactions. Consequently, it is included in a transaction without the need for any intervention from a human being (. In contrast to traditional contracts, the primary emphasis here is on facilitating low-cost transfers and automating transfer processes based on a decentralized network operating worldwide. In addition, as compared to conventional contracts, smart contracts provide a greater level of security, cheaper overall costs, and fewer delays. Building on this, enhanced contractibility and increased enforceability are possible with smart contracts, which allow for automated payment flow operation. A rise in contractibility, on the other hand, would call for a more robust circulation of information, which has a doubtful likelihood of being accepted in the economic sector. In particular, smart contracts are suited for supply chains that are transient and dispersed, consisting of many layers with a large number of suppliers and contractors (De Giovanni, 2020).

Monitoring of Logistical Operations and Supply Chains Using Blockchain the Part Played by Blockchain in the Supervision of Supply Chains The supply chain management system may benefit significantly from blockchain technology. The use of blockchain technology improves partners' ability to communicate. Because of this, the process will be simplified, with shorter lead times, decreased duplication, fewer delays, and a leaner supply chain. In addition, it gives the seller a greater degree of control over the manufacture of the product from beginning to end, which guarantees that quality requirements are fulfilled. Through mapping and visualization of business supply chains, blockchain technology may help improve operational efficiency by using traceability to enhance operational efficiencies.

Platform	Blockchain	Cryptocurrency	Smart Contracts
Ethereum	Public and Permission-based	Ether	Yes
Hyperledger Fabric	Permission-based	None	Yes
Multichain	Permission-based	Multi-currency	Yes
Litecoin	Public	Litecoins	No
Lisk	Public and Permission-based	LSK	Yes

Figure 4 : Platforms and smart contracts

One of the most critical factors that highlight the significance of blockchain traceability is the persistently growing demand for obtaining information about items. Blockchain technology may make the end-to-end monitoring of a supply chain more transparent and accurate. To trace assets from the point of manufacture through delivery or usage by an end user, businesses may digitize their physical assets and generate a decentralized, immutable record of all transactions via the use of distributed ledger technology (DLT). The problems that are experienced in the supply chain and logistics domain, such as lack of security, visibility, and transparency of various operations; transactional issues; errors caused by human intervention; delays in processing,

updating, or sharing data and information; and slowness in the delivery of goods and services; can be solved by blockchain because it offers transparency, traceability, immutability, trust, and security. Other problems that can be solved include errors caused by human intervention; transactional issues; manual errors; and delays in processing, updating, or sharing data. The material flow, the data flow, and the money flow are the three distinct flows in SCM. The movement of materials and goods from one location to another is an example of material flow. Data flow refers to the transmission process that occurs between the location where the goods are produced and the location where they are utilized. Money flow includes the costs associated with each product or well made during the process (Hu & Ghadimi, 2022). Blockchain technology will allow all of these fundamental flows of the supply chain process to be managed. In addition, blockchain technology offers several applications to help revolutionize how supply chain procedures and other commercial activities are organized.

2.1 SAP and Blockchain managing supply chain

Compared to other comparable blockchain systems, the SAP Blockchain has a distinctively different mode of operation. It is not intended to implement the basics of blockchain technology; instead, it is designed to create an excellent environment for users and customers to incorporate the blockchain framework into their systems. The following list is some of the most important reasons we need it. GreenToken by SAP is a system that enables transparency of the utilization of raw materials before certain goods enter a supply chain. This transparency is achieved by blockchain technology, which is a relatively new technology. Companies are now required to comply with Environmental, Social, and Governance regulations, which include requirements such as ensuring that specific resources are acquired sustainably. In addition, companies may be motivated to provide sustainable sources of materials because many customers are eager only to purchase products that comply with these values, regardless of whether or not these values are written into law. This can motivate companies to ensure sustainable sources of materials (Collart & Canales, 2022).

When developing any of the blockchain services covered by the SAP platform, careful consideration is given to the expansion and growth of businesses. As a result, storing the essential aspects of an organization's operations, such as its use cases, affected processes, data integrity, and quality, is more straightforward. In this manner, it simplifies businesses' process to include these kinds of products into their platform. Integrating blockchain services based on SAP into your company guarantees that the networks will function faultlessly, which is necessary for success in operations. Their unparalleled knowledge of network administration makes it possible for businesses to conduct transactions in a risk-free and dependable setting. The

platform's primary emphasis is on streamlining the many means transit companies may use to allow trading across various regions. Every stage of the transportation process, including but not limited to buyers, sellers, authorities, and banks, and monitoring process statuses, may be accounted for in real-time.
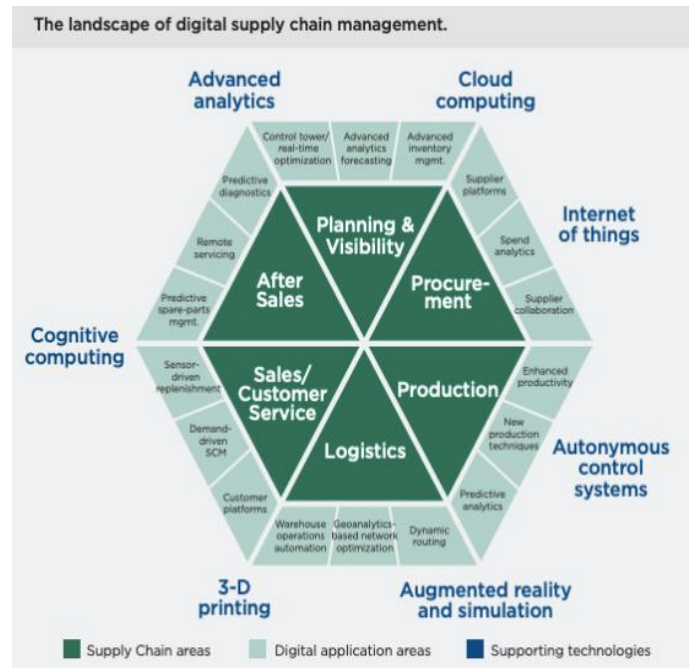

Figure 5 : Digital Supply Chain Landscape

SAP Blockchain allows the monitoring and reporting of different business processes and items, regardless of where in the supply chain they are located. Because it uses blockchain technology, the SAP platform can now perform seamless monitoring while making the information provided immutable and tamper-proof. Keeping to the rules on product authenticity and provenance will be much simpler for firms in this manner. Businesses can access and trace back the information on the Blockchain platform, in addition to using the worldwide tracking capability. It functions as a trustworthy and effective instrument for combating any fraud in the Treasury. By creating a straightforward and auditable source that is to be accounted for by the provider, the platform makes the environment resistant to theft. Within the forum, the buyers and sellers are positioned across a shared repository in conjunction with one another. In this manner, it guarantees access with a single tap to the procedure the supplier uses to update the master data while ensuring the preservation and suitability of business ties. Suppose blockchain network users need to satisfy specific requirements (such as being an employee or partner in a firm) to access it. In that case, the blockchain network may be classified as a private network, a partly private network, or a public network (Smith, 2020).. Another kind of blockchain is called a consortium. Under this model, access privileges are managed by a pre-selected set of participants,

such as companies working together on a supply chain. Users of this network could be required to possess various kinds of authorization, depending on their positions within the organizations, so they can either read the information in the blockchain or make changes.

This technology may have a variety of uses at this point. Smart contracts, blockchain-based securities trading, blockchain-based land registries, and the prevention of electioneering fraud are just a few examples of the applications of blockchain technology. However, this project's scope will be limited to exploring the possible uses of blockchain technology in the logistics business and providing further information on its implementation in this particular sector. Wong et al., (2020) describes that use of blockchain technology has the potential to vastly simplify or do away with the problems that have been outlined above in the modern supply chain. The use of blockchain technology increases the effectiveness, efficiency, and transparency of supply chain operations while simultaneously decreasing the amount of time and cost associated with individual transactions. There are many different ways in which the supply chain might benefit from blockchain technology.

2.2 The rationale for blockchain in supply chain management

Blockchain-based supply chain solutions have been proposed for centralized network environments. These solutions sidestep the difficulties of having an open and distributed peer-to-peer architecture, but they disregard the distributed network's intended robustness, scalability, and affordability. In general, blockchain research focuses on facilitating three primary functionalities: tracking (e.g., provenance, proof of origin), transfer (e.g., smart contracts), and payment. Current research around blockchain focuses on facilitating three main functionalities. Recent developments have suggested that Ethereum, a peer-to-peer blockchain programming language, will support all three (Hu et al., 2022). Relational databases were the standard for a considerable amount of time and were the data model of choice for most data management approaches. Despite this, there has been an increase in demand for solutions that accommodate flexible schema and heterogeneous data. These requirements paved the way for the development of NoSQL databases.

The digital and data-driven supply chain of the future can solve many of the issues that continue to plague supply chains today. However, to create such a sophisticated setting for supply chain management, enormous amounts of research and development of high-potential technologies are necessary. Blockchain is one of those technologies that have the potential to have a significant impact on the way supply chains are managed in the future. Technology is the focus of this thesis, which examines it in greater detail. Large companies such as IBM and SAP are already offering

solutions based on blockchain technology to their customers, even though blockchain is a technology that has only recently begun to gain traction in the market (Song et al., 2019). The following paragraph will walk you through some of the current initiatives being pursued and provide a glimpse of the exciting potential that this cutting-edge technology holds for the supply chains of the future.

Consumer goods are being produced, transformed, and distributed globally by an increasing number of players. In this industry, visibility and traceability provide deeper insight into assets at every stage of the product's life cycle. In the meantime, new technologies and those still in development make it possible to design, optimize, and manage supply chains in more intelligent and faster ways. One of these up-and-coming technologies is the blockchain, best known for being the technology that lies beneath cryptocurrencies. The purpose of this section is to examine the potential and problems that blockchain technology presents for use in supply chain and logistics, as well as to discuss the advantages and disadvantages of the technology in the context of the industry.

2.4 Actual world application of blockchain in SAP and supply chain

The collaboration between GreenToken by SAP and Unilever, which attempts to address these concerns, was recently announced. GreenToken is a blockchain-based solution that is operated on a Quorum enterprise blockchain. Customers and other participants in the supply chain may use digital twin tokens to determine the percentage of sustainable materials included in a particular product. A mass balancing system allows for unalterable tracking of the inputs and outputs of all raw materials used. At the very end of the procedure, a token is generated for the product. This token offers an audit trail that can be retrieved from the blockchain ledger about the product's origin. SAP is one of many companies working on establishing a system for monitoring the supply chain. In January, Maersk and IBM made public their plans to collaborate on the development of a blockchain-based electronic shipping system. This system would digitize existing supply chains and enable real-time tracking of international freight. SAP client Modum, a start-up provider of Internet of Things sensors and tracking software, has worked with SAP Innovation Center Network to bring sensor data and SAP's cloud blockchain service. Modum is a vendor of Internet of Things sensors and tracking software (De Giovanni, 2020).

The "blockchain as a service" (BaaS) offered by SAP comes in the form of an abstraction layer and has built-in integration for SAP applications. Using SAP Leonardo by customers to connect blockchain with other technologies, such as big data analytics, machine learning, and Internet of Things (IoT) applications, is another goal of SAP. "SAP Cloud Platform Blockchain as-a-service (BaaS) offers the quickest and

lowest-risk entrance to experimenting with distributed ledger technology in the cloud," says SAP. "BaaS" stands for "blockchain as a service." SAP has high expectations that it will be able to win over clients that want to accelerate the use of blockchain technology in their companies (Treiblmaier et al., 2022). The sensors manufactured by Modum can monitor packages' temperature, humidity, vibration, and light exposure while they are in transit. This enables clients to comply more easily with safety laws or quality criteria. The sensors on a box can be synchronized with an app running on a mobile device using NFC or Bluetooth. Then, the data from the sensors can be uploaded to a blockchain ledger, which uses innovative contract technology to automatically set the parameters on the Internet of Things device that are necessary for safe shipment.

3. Adoption of Blockchain in SAP Supply Chain Management

3.1 Methodology

The inductive techniques (also known as qualitative methods) and the deductive methods (also known as quantitative methods) are the two forms of data gathering approaches that may be used to meet the primary goals of the study. The study approach for the secondary data is shown below. The AHP technique has been used with the intention of achieving the aim of improving the utilization of blockchain technology in supply chain management, in particular when making comparisons within the same sector. In this research, a total of eight components, including decentralization, resilience, security, smart contracts, sustainability, traceability, transparency, and trust, are investigated in order to build the AHP model. These components are listed in alphabetical order. In addition, the computation of a Desirability Index has been created for both traditional supply networks and supply chains that are enabled by blockchain technology.

The researcher has the option of using any research technique, including qualitative data, quantitative data, or a strategy that combines both qualitative and quantitative data. The interpretivist research philosophy is used by the qualitative research technique. This research design is suited for study in which new insights need to be derived from previously acquired information or the phenomena is not well understood. The analysis of blockchain technology and how it may be used to improve supply chain management lends itself naturally to a qualitative approach to research; as a result, this approach is the one that should be used whenever possible. In light of the fact that this study intends to investigate the effects of using blockchain technology in supply chain management, an exploratory research technique will be used.

In order to undertake an analysis that was as objective as possible with regard to the subject matter of BCT and SCM, a detailed and methodical literature review was carried out in six parts. The seven stages that Freels and Onwuegbuzie (2016) outlined serve as the foundation for the six steps [22]. [Citation needed] In order to accomplish this goal, the seven processes were rethought and reorganized according to the subject matter. In this part, the technique is going to be broken down into the most understandable terms possible.

The development of a comprehensive comprehension of the subject matter;

- The elucidation of two primary subjects, a subject area, and the definition of keywords that follow;

- Executing a preliminary search in chosen databases;

- Executing the search in many available or relevant databases;

- Executing a previous assessment of the quality of the literature; 6. Executing a comprehensive analysis and categorization of the literature that was selected.

It is vital to have a complete comprehension of the issue in order to determine the two primary subjects and the subject area. Following this step, the necessary keywords for the search will be determined. It is possible to assess the effectiveness of the keywords and make any required adjustments by first doing the search in a subset of the databases. After that, the meat of the investigation was carried out by using Science Direct (SD) and Web of Science (WoS). The literature was appraised thematically, taking into account the titles and, where relevant, the abstracts. Search keywords and impact factors were also used for the purpose of this evaluation. After that, the "literature research," also known as the exploration phase of the literature review, is finished, and the "literature interpretation" or "literature analysis" of the obtained material is started. The accumulated body of work may then be scrutinized further and organized into appropriate categories.

3.2 Findings and analysis

The most accurate way to define blockchain as a technology is as a method for the creation of a decentralized immutable ledger of data (which can be a record of any kind of data) that is stored across a network of computers. As a result of the fact that it cannot be altered in any way, blockchain possesses extremely high levels of robustness because it is resistant to change. In terms of recent developments, SAP has provided specifics of new work, which has resulted in the participation of 27 clients and partners in SAP's blockchain co-innovation project. The goal of the program is to use the SAP Cloud Platform Blockchain service in order to

incorporate the blockchain digital ledger system with Internet of Things software installations inside industrial and digital supply chain operations (Howson, 2020).

The power in today's market is with the end users. A movement of individuals who are looking for methods to make good choices about what to purchase and for a solution to the harmful influence that consumerism is having on our planet. This movement is also looking for a solution to the problem that consumerism is causing. They are requesting information on the processes and resources that are used to provide the items. Consumers are acutely aware of how shops and brands do business, including how they handle employees, how much water and garbage they use, what constitutes acceptable labor practices, what health and safety regulations they adhere to, and so on. If the name of a brand is connected in any way to any of these controversial subjects, the brand's reputation will suffer as a result. The major brands of today have an obligation to be perceived to be pursuing some kind of sustainability plan (Mattke, et al., 2019). Because buyers are seeking more transparency, the only items that are acceptable to sell are those that have a clear and extensive provenance. In the event that the supply chain is unable to provide them, the name of the brand will suffer as a result.

3.3 Co-innovation network

Co-innovation between SAP and its clients and partners is being used to develop use cases for blockchain technology that can be standardized and so allow widespread adoption in digital supply chain and SAP Leonardo Internet of Things deployments. These use cases include the following: The SAP Asset Intelligence Network is a cloud-based business network and global registry of equipment that provides a digitization platform for original equipment manufacturers (OEMs). This platform is used by OEMs to share asset information with operators and service providers in order to improve service targets and increase asset uptime. A network-based solution that provides a private platform for customized production and collaborative manufacturing with suppliers is known as SAP Distributed Manufacturing (for example, 3D printing service suppliers, material providers, OEMs and technical certification companies). A use case for blockchain in international commerce with SAP's Transportation Management system The ability to electronically communicate, examine, and sign papers, as well as follow the progress of various processes and transfer over ownership of an e-Bill of lading, would be available to sellers, purchasers, banks, and authorities. The goal of a safe container release procedure is to cut down on fraudulent activity and stolen cargo (Bumblauskas et al., 2020).

Real-world applications that use any component of SAP's blockchain-driven supply chain management might include the following categories and subcategories, among others: SAP Transportation Management is designed to assist in the

management of electronic invoices and document signing for freight and haulage. SAP Global Track and Trace is a system that can monitor and report on the movement of items and business activities across several supply chain networks. Farm to Consumer: to provide businesses with the capacity to track the origins of food items along the whole of the supply chain and to assist in the preservation of the quality of the food supply. SAP Advanced Track and Trace for Pharmaceuticals: to comply with serialization and worldwide reporting standards in the endeavor to combat the illicit trade and counterfeiting of pharmaceuticals (De Giovanni, 2020).

3.4 Customer satisfaction and industry changes

The findings are almost unanimous: 99.5 percent of respondents perceive blockchain as an opportunity. This figure represents an increase from earlier this year, when 92 percent of respondents held this opinion. Eighty-four percent are now involved in activities that are linked to blockchain technology, which is the same number as was found in both our Spring 2018 research and a survey conducted by PwC in August. Things that were promise six months ago have continued to look positive throughout 2018: interest is widespread, and adoption is becoming more and more real. In addition, there is a wide range of adoption; our research revealed that many different sectors are aggressively pushing use cases. In previous years, the general public's opinion of blockchain was that it was identical with cryptocurrencies. After nine months, the prices of cryptocurrencies are still in flux, while use cases for cryptocurrencies are becoming more widespread in supply chains and increasingly in corporate finance (Saadiah, 2021).

SAP has expanded its client base in the supply chain via the use of global track and trace, particularly for pharmaceutical firms, transportation management, and farm-to-consumer solutions. However, we also see expanding opportunities to complement the work of the corporate finance department. The majority of respondents identified expedited financial transactions as the most critical use case for SAP blockchain technology. This category includes audits, taxes, and regulatory transparency. Diversity is also important when considering the internal stakeholders who are responsible for pushing adoption. Individual line-of-business executives were the most prevalent stakeholders, followed by the CIO or IT department, which is another evidence of blockchain's expanding reach throughout the corporation.

The power in today's market is with the end users. A movement of individuals who are looking for methods to make good choices about what to purchase and for a solution to the harmful influence that consumerism is having on our planet. This movement is also looking for a solution to the problem that consumerism is causing. They are requesting information on the processes and resources that are used to provide the items. Consumers are acutely aware of how

shops and brands do business, including how they handle employees, how much water and garbage they use, what constitutes acceptable labor practices, what health and safety regulations they adhere to, and so on. If the name of a brand is connected in any way to any of these controversial subjects, the brand's reputation will suffer as a result. The most successful companies of today have to demonstrate that they are pursuing some kind of environmentally responsible plan. Because buyers are seeking more transparency, the only items that are acceptable to sell are those that have a clear and extensive provenance. In the event that the supply chain is unable to provide them, the name of the brand will suffer as a result..

3.5 Transaction and company security

The public sector is investigating the feasibility of using blockchain technology to create an official register for government-owned and privately held assets, such as buildings, homes, automobiles, and patents, among other things. Voting might be made easier with blockchain technology, fraud could be reduced, and back-office operations like buying could be improved. Because the blockchain renders these procedures completely "trustless," the technology is well suited for application in the public sector, which has stringent standards that must be analyzed and validated before being implemented. The use of blockchain technology is increasing accountability as well as transparency across the supply chain (Bernards et al., 2022). Companies in practically every industry are using technologies to monitor and trace items back to the source, establish authenticity and origin, stay ahead of recalls, and speed up the flow of goods..

The food supply chain is one industry that has seen significant use of blockchain technology, namely for the purpose of tracking perishable goods from the farm to the consumer's table. Food makers have the ability to invite anybody they want to join in the network by using a blockchain that is permissioned. This includes food aggregators, sustainable farmers, and even individual growers. At the time of harvest, the product is given a QR code that includes information such as its place of origin, the name of the producer, and whether or not it is organic or comes from a firm that practices fair trade. As the data flows through the supply chain, it is encoded into the blockchain and updated with any new information that becomes available. In this manner, if there is a product recall, producers will be able to utilize the blockchain to zero in on which batches were impacted, which would reduce the amount of waste and expense associated with a larger-scale recall. And after the product has been delivered, merchants and customers are able to utilize the QR code to access essential product information, even for different fruits combined into a single smoothie.

4. Cases of application of blockchain in SAP supply chain management

The supply chain difficulties faced by businesses increase in tandem with their digital transformations. This will, in many instances, necessitate the digitalization of antiquated operations, and the technology behind blockchain is proving to be a crucial enabler for digital transformation in the supply chain. Blockchain technology, which functions as an immutable, distributed ledger, provides unparalleled levels of security and facilitates the development of peer-to-peer connections that are characterized by increased levels of trust. SAP is optimistic about the widespread use of blockchain technology that is now being observed. Customers participating in the company's co-innovation initiative are said to come from a variety of different industries, including consumer product development, telecommunications, retail, logistics, agriculture, aerospace and defense, industrial machinery, and energy and utilities, according to executives at the company (Waller et al., 2019).

Transactions between a company and its suppliers may be made more straightforward and risk-free with the use of smart contracts, which are a powerful tool in this regard. A smart contract, despite the fact that it performs the same function as a traditional contract, is not, in fact, a contract at all. Consider a smart contract to be a piece of code that, in addition to storing and verifying rules, automatically executes those rules. The smart contract is where the stipulations of the deal between a company and its supplier are stored. The contract is considered "executed" after both parties are satisfied that all of the provisions of the agreement have been fulfilled. The money is sent to the vendor, and the firm is given the items it ordered. The terms of the smart contract will be preserved in perpetuity on the distributed ledger, where they are immune to modification by any participant in the transaction. This peer-to-peer (P2P) network, on which blockchain is constructed, has the function of distributing power among its peers rather than keeping it centralized in the hands of an intermediary.

Pharmaceutical firms are confronted with a significant obstacle in the form of the reduction in the number of counterfeit goods that are sold in the market. Customers are given the assurance that the product they purchase from businesses who use anti-counterfeit labels on their products are given proof that the product is in fact precisely what it is represented to be. SAP has introduced a whole new blockchain solution with the intention of resolving the authentication problem that has been plaguing the sector. The Information Collaboration Hub for Life Sciences is a new public cloud system that has been designed to facilitate collaboration among supply chain trading partners. This, in turn, enables drug wholesalers to authenticate pharmaceutical shipments. The system is called the Information Collaboration Hub for Life Sciences. The solution will assist firms in ensuring that their systems are in

compliance with the US Drug Supply Chain Security Act (DSCA). It would seem that there is an infinite number of use cases both inside and outside of the supply chain. A technology that was formerly most usually linked with cryptocurrencies has shown that it may have a significant influence across a variety of industrial sectors (Rajora, 2022). The use of blockchain technology is making supplier relationships stronger, improving track-and-trace capabilities, and placing businesses in a position to provide their clients with a better level of protection on a daily basis.

4.1 Challenges of the technology in supply chain

Before making the decision to deploy blockchain technology, businesses need to be aware of the myriad of possible complications that might arise due to the novelty of the underlying technology. The possibility of duplicate spending arises as a drawback of the blockchain technology. Even if the blockchain technology was developed to address the issue of double spending, it is still possible for it to take place. After deploying blockchain technology, one of the most basic challenges that companies could encounter is the possibility of double spending. When a person makes several payments using only one kind of funds, they are committing double spending. Transactions are authenticated by the successful completion of a mathematical problem, therefore this is a possibility.

When payments that haven't been processed yet are sent out into the network, there is a risk of broadcasting disturbances, which may lead to duplicate spending (Hasanova et al., 2018). By accomplishing the following, for instance, an adversary may successfully deceive a shop into accepting a transaction that the merchant would be unable to cancel. The adversary in this situation may begin a transaction identical to the first one, with the exception that they would alter the address of the receiver. Multiple transactions that use the same inputs will not be accepted by the chain if they are started at the same time to different peers on the chain. Instead, they will only acknowledge and approve of the transaction in the form in which it was communicated to them initially. Despite this, the transaction may be broadcast to other peers, which would make it successful in its attempt to cause double spending. Companies will never be able to eliminate their exposure to the risk of double spending since there is no way to prevent it.

5. CONCLUSIONS

The findings of this article lead us to the conclusion that blockchain implementations at scale are mostly in the pilot stage (proof of concept). At this time, there is no evidence to suggest that widespread adoption has taken place within the supply chains. According to Wang and colleagues' 2019 research, there is currently little empirical evidence to suggest that blockchain technology may significantly disrupt supply chains in the near future. 43 Indeed, a lack of awareness of the foundations of blockchain technology and its potential to positively influence supply chains is one of the most significant difficulties that organizations face today. It is possible to stimulate and expedite blockchain's acceptance in supply chain and logistics operations via the participation of stakeholders, the continuation of empirical research utilizing data from supply chains, and simulations of the implications of blockchain on supply chains. The supply chain is a complex network of interconnected networks, channels, and businesses that, by leveraging global logistics and synchronizing supply with demand, assists in the provision of goods and services that are required by end customers with the goal of producing net value and constructing a competitive infrastructure.

As a linking technology, it presents a chance to allow improved process integration inside an organization, which is a significant opportunity. When combined with mobility, nearly infinite data storage, machine learning / AI, data science at scale, predictive analytics, and IoT, blockchain enables businesses to ponder more advanced methods to monitor and expose the production trajectory of their goods. Investing in blockchain is equivalent to investing in the future. It is an investment that cannot be avoided. The hazards may be reduced if the CXO exercises some prudence and takes the appropriate strategy. The technology behind blockchain has the ability to bring about massive change. The greatest partners to assist the implementation of this technology are enterprise solution providers like SAP, since they offer the appropriate strategic and technical support for your blockchain journey.

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