A Project Report

on

Logistics and Supply Chain Management over Blockchain

Submitted in partial fulfillment of the

requirement for the award of the degree of

Bachelor of Technology in Computer Science and Engineering

Under The Supervision of
Mr. Vikas Shrivastava
Assistant Professor
Department of Computer Science and Engineering

Submitted By

19SCSE1010750 - Akshansh Nahar

19SCSE 1200002 – Dev

SCHOOL OF COMPUTING SCIENCE AND ENGINEERING

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

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CANDIDATE'S DECLARATION

I/We hereby certify that the work which is being presented in the project, entitled **"*Logistics and Supply Chain Management over Blockchain*"** in partial fulfillment of the requirements for the award of the **BACHELOR OF TECHNOLOGY IN COMPUTER SCIENCE AND ENGINEERING**

submitted in the **School of Computing Science and Engineering** of Galgotias University, Greater Noida, is an original work carried out during the period of **JULY-2021 to DECEMBER-2021**, under the supervision of **Mr Vikas Shrivastava, Assistant Professor**, **Department of Computer Science and Engineering** of School of Computing Science and Engineering , Galgotias University, Greater Noida

The matter presented in the project has not been submitted by me/us for the award of any other degree of this or any other places.

19SCSE1010750 – AKSHANSH NAHAR

19SCSE1200002 – DEV

This is to certify that the above statement made by the candidates is correct to the best of my knowledge.

Supervisor

(Mr Vikas Shrivastava,

Assistant Professor)

CERTIFICATE

The Final Thesis/Project/ Dissertation Viva-Voce examination of **19SCSE1010750 - AKSHANSH NAHAR, 19SCSE1200002 – DEV** has been held on _____and his/her work is recommended for the award of **BACHELOR OF TECHNOLOGY IN COMPUTER SCIENCE AND ENGINEERING**.

Signature of Examiner(s) **Signature of Supervisor(s)**

Signature of Project Coordinator **Signature of Dean**

Date:

Place:

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ABSTRACT

New technologies are presenting promising opportunities for improvement across the supply chain. Using blockchain in the supply chain has the potential to improve supply chain transparency and traceability as well as reduce administrative costs.

A blockchain supply chain can help participants record price, date, location, quality, certification, and other relevant information to more effectively manage the supply chain. The availability of this information within blockchain can increase traceability of material supply chain, lower losses from counterfeit and gray market, improve visibility and compliance over outsourced contract manufacturing, and potentially enhance an organization's position as a leader in responsible manufacturing.

Blockchain driven innovations in the supply chain will have the potential to deliver tremendous business value by increasing supply chain transparency, reducing risk, and improving efficiency and overall supply chain management.

Blockchain can enable more transparent and accurate end-to-end tracking in the supply chain: Organizations can digitize physical assets and create a decentralized immutable record of all transactions, making it possible to track assets from

production to delivery or use by end user. This increased supply chain transparency provides more visibility to both businesses and consumers.

Blockchain can drive increased supply chain transparency to help reduce fraud for high value goods such as diamonds and pharmaceutical drugs. Blockchain could help companies understand how ingredients and finished goods are passed through each subcontractor and reduce profit losses from counterfeit and gray market trading, as well as increase confidence in end-market users by reducing or eliminating the impact of counterfeit products

INTRODUCTION

Blockchain is everywhere. One major promise of Blockchain is to create transparency – every member of the network has access to the same data, providing a single point of truth. Supply chain transparency is one of the most important and hardest to achieve improvement areas for logistics and SCM. It comes as no surprise that some logistics experts consider Blockchain to offer "enormous potential", to be a "much-needed platform for economic renewal", and to "transform the supply chain and disrupt the way we produce, market, purchase and consume our goods". Taken together, Blockchain might be nothing less than the "holy grail".

The acceptance of BT as a tool to enhance security benefits and revolutionize supply chain practices would take a considerable amount of time until its benefit potential is fully realized and backed by many success stories. To speed up the BT application process, we need to understand how BT typically works. Figure 1 demonstrates the inner workings of BT. As no one owns a blockchain ; no one can delete a block from the chain and anyone can add to it. As such, the blockchain allows anyone to transfer his/her assets——including intangible assets——without the risk of hacking and building silos that limit interactions among trading partners. In addition to the security benefit, BT can bring a multitude of managerial benefits to everyday business practices, including:

- Reduced transaction costs/time resulting from better-preserved blockchain platforms that do not necessitate third-party involvement;
- Visibility improvement across the supply chain, a result of increased transparency gained via open ledgers that any person can see; and

- Improved connectivity among trading partners through the integration of digital and physical worlds, which includes a shared visibility of transactions and information flows across the supply chain.

Blockchain is often regarded as a very secure technology due to its heavy use of cryptography. How bitcoin runs well despite booming worldwide while having no central authority proves its security. Some even say that it has never been hacked . Blockchain is a digital ledger technology which transactions are immutable (can't be altered), is distributed in the network without the need for trust, and keep growing as transactions keep getting recorded. Just like a real ledger, blockchain keeps a complete record of every transactions ever happened there. There is no central server in blockchain; every node works together to run the system with (ideally) equal standing. Because there's no central server, every node keeps a copy of the ledger. This is part of how blockchain keeps the system secure despite having it run by mutually distrusting nodes. Blockchain was meant to be a publicly distributed ledger, but there are also other types of blockchain. In private blockchain, there are certain level of trust on some nodes. This makes the blockchain kind of centralized, so the key to security is held by those trusted nodes. Private blockchain is usually used for internal organization system. In private blockchain, new participants needs to be accepted by the manager, the trusted nodes. Private blockchain can also restrict participants privileges. Consortium blockchain is a private blockchain with larger scale. Consortium blockchain is usually used for a system that includes many organizations, for example, supply chain management information system. Supply chain is a sequence of processes and flows that aim to fulfill end customer requirements and take place between companies involved. Supply chain doesn't only include manufacturers and suppliers but also logistic entities, retailers, and end customers themselves. Traditional supply chains suffer from bullwhip effect, causing overestimations over demand spikes that grows bigger as it goes uphill the supply chain. That effect is caused by limited knowledge of the actual demand and requirements, limited view of the customer end of the chain. This is the main reason why supply chain management is needed

LITERATRURE SURVEY

As introduced, Blockchain is considered to offer large potential for improving processes and enhancing business models in logistics and SCM. However, according g to a recent study on trends in logistics and SCM, Blockchain is only known to some logistics experts and even fewer pursue implementation plans ([1] , Hackius, N., & Petersen, M. (2017)). The four main use case on which Peterson gave his overview are Ease in Paperwork Processing in Ocean Freight, Identify Counterfeit Products, Facilitate Origin Tracking, Operate the Internet of Things.

The acceptance of BT as a tool to enhance security benefits and revolutionize supply chain practices would take a considerable amount of time until its benefit potential is fully realized and backed by many success stories. To speed up the BT application process, we need to understand how BT typically works. No one owns a blockchain , no one can delete a block from the chain and anyone can add to it. As such, the blockchain allows anyone to transfer his/her assets——including intangible assets——without the risk of hacking and building silos that limit interactions among trading partners. In addition to the security benefit, BTcan bring a multitude of managerial benefits to everyday business practices ([2] Min, H. (2019)), including :

Reduced transaction costs/time resulting from better-preserved blockchain platforms that do not necessitate third-party involvement;

Visibility improvement across the supply chain, a result of increased transparency gained via open ledgers that any person can see; and

Improved connectivity among trading partners through the integration of digital and physical worlds ([2] Min, H. (2019)), which includes a shared visibility of transactions and information flows across the supply chain.

BCT provides four key features that can enhance integration and coordination among the members of an SC : (1) transparency, (2) validation, (3) automation, and (4) tokenization. Transparency relates to the shared ledger of information which is aggregated from various sources and participants of the blockchain. Immutability of records and consensus-based verification enable validation of information . Automation refers to the opportunity to execute smart contracts based on verified information on the blockchain. BCT allows creation of tokens that represent a specific claim on any valuable asset and their exchange between blockchain members (tokenization) . Enabled by these four key features of BCT, one can derive corresponding use case clusters in SCM that build on one another. ([3] Blossey, G., Eisenhardt, J., & Hahn, G. (2019).)

1. SC Visibility: One of the main causes for SC inefficiencies is poor end-to-end transparency which also leads to the so-called bullwhip effect . BCT allows sharing real-time information about the location and status of an object between multiple SC members

2. SC Integrity: Given a shared ledger of transparent and immutable records, BCT provides the opportunity to trace assets back to their origin

3. SC Orchestration: Combining transparency and validation with automation via smart contracts, one could envision SCs that operate highly automated based on pre-specified rules

4. SC Virtualization: Virtualization is a well-known approach in IT infrastructure management to increase utilization and flexibility of IT assets by creating a logical representation of physical hardware in software [46].

5. SC Finance: Applications supporting financial SCM are a natural ‘fit’ for BCT given the close ties to cryptocurrencies and the important role of

financial intermediaries in global trade . Consequently, there are two types of applications: first, BCT eases the settlement of multi-party and multi-tier financial transactions in SCs that result from collaborative value creation of blockchain members. Second, transparent and validated records as well as automated transactions and tokenized financial claims simplify financing of working capital ,including inventories and accounts receivable net of accounts payable from blockchain members which also lowers financing costs .

This model utilizes behavioral intention (BINT) as a predictor of behavioral expectation . According to ([4] Queiroz, M. M., & Wamba, S. F. (2019)), "Behavioral expectation […] reflects the strength of the focal behavioral intention over other (competing) behavioral intentions". This implies that "BINT will lead to formation of BEXP" [… and that] this further reinforces the idea that BEXP reflects both internal and external factors in predicting behavior".

Performance expectancy (PEXP) is defined as "the degree to which an individual believes that using the system will help him or her to attain gains in job performance". In our study context, performance expectancy refers to the degree to which an employee perceives that using the blockchain technologies will improve their productivity and performance.

Social influence (SINF) is defined as "the degree to which an individual perceives that important others believe he or she should use the new system" ([4] Queiroz, M. M., & Wamba, S. F. (2019)). For the purpose of this study, social influence will refer to the extent to which the employee comprehends the relevance of why others believe they should use the blockchain technology

Facilitating conditions (FCON) are defined as "the degree to which an individual believes that an organizational and technical infrastructure exists to support use of the system" (([4] Queiroz, M. M., & Wamba, S. F. (2019)). In our study, they will refer to employee's understanding of the resources that are available in organizations to support the use of blockchain

Blockchain transparency Transparency in supply chain context can be defined as "how supply chain information is communicated to stakeholders". In our study, blockchain transparency (BTRAN) refers to the models through which an

organization communicates and reports its action to its relationships across their supply chain network, so as to support the visibility of the operations at all levels. In an SCN perspective, blockchain can improve the transparency and accountability

Trust of supply chain stakeholders . In a supply chain context, relationships between organizations are a fundamental to their operations. For example, a relationship involving information sharing is critical for operations performance. Unfortunately, the supply chain network generally lacks transparency among the members, which represents a considerable difficulty for organizations. An efficient solution to this is the integration of blockchain technologies, as they can minimize uncertainty and empower transparency throughout the entire supply chain as well as supply chain traceability . Moreover, blockchain can improve the level of trust between supply chain members

Blockchain is such an innovation which is capable of remodeling supply chain management by providing realtime transparency and coherent traceability of supply chain operations, which increases trust in the business and maximizes efficiency gains ([5] Khanna, T., Nand, P., & Bali, V. (2020).)

A proposed blockchain system ([5] Khanna, T., Nand, P., & Bali, V. (2020).)which collects, stores and manages data regarding each product and what changes it goes through (because of the various actors in the supply chain), during the life cycle of the product. The system consists of different actors like, registrars, standard organizations (like in India, there is Food Safety and Standards Authority of India (FSSAI), and certifiers which are connected to the manufacturers, retailers, distributors and the consumers in a peer-to-peer connection. The registrars and standard organizations provide identities, standard schemes, and certifications to other actors. Contrary to bitcoin network, which is a public open access blockchain, the supply chain management will require a private implementation of the blockchain, which can be managed by the business itself. Every actor is responsible to record the status of the product and enter specific product data into the blockchain. Smart contracts deployed ensure that assets can be tracked easily from any participant running the blockchain interface. The access

of the data depends on what type of actor is accessing the blockchain. These access rules are coded in the smart contracts. Every new product has a digital profile created on the blockchain. Whenever a product goes from one actor to another actor in the supply chain, the ownership of the product gets changed, which isreflected in the public ledger. The new actor keysin important data specific to the data and its own role in the supply chain. Once the exchange is done, this transaction is recorded in the blockchain. Both the actors have to prove their identity using their private key, because of which there is a lowered risk of identity forging. This data can be entered either manually or automatically using RFID, QR code, etc. Some of this data can be location of the product, which actor currently owns the product, what processes have been applied to the product, time stamp of the exchange of the product, some product specific data.

Real-time tracking and tracing are important in providing a unified view of global supply chains consisting of several parties. This paper illustrates the needs and requirements for managing supply chains in multi-company project environments by adopting various tracking and tracing technologies. This kind of tracking and tracing is especially needed within distributed architectures engaged in project-based businesses, where several vendors are involved in a single project. Such tracking and tracing data can be used extensively to generate key performance indicators, which can be used to measure and control supply chain processes.([6] Helo, P., & Shamsuzzoha, A. H. M. (2020))

The most well-known applications of blockchain are related to cryptocurrencies, but increasingly also in digital asset management. Trade-processing and settlement is an obvious continuation of payments. ([6] Helo, P., & Shamsuzzoha, A. H. M. (2020)) As data immutability is verifiable, this may be used for signing transactions or verifying the authenticity of an item, contract or right to use. These features are looked at especially in government registers and medical industries. Industrial uses reported in the literature include open manufacturing environments, IoT connectivity , origin authenticity and product safety . The possible advantages of blockchain systems are: (1) Decentralized management of the system as all participants share the need for immutable data and transparency of the process; (2) The data can include transaction data on a high level or detailed documentation related to products, custom processes or release of payments; (3) Improved trust

through increased supply chain visibility and fraud detection ; (4) A shared and scalable network providing a basis for mutual interest.

Some examples of how to use real-time data streams for supply chain decision-making include the following: - Route planning for trucks in real-time; - Quality management by analyzing customer feedback and delivery issues on-line; - Profitability analysis for trucks, routes and stock-keeping units; - Order patterns and customer behavior over time; - Risk management analysis based on orders and current status of deliveries.

Blockchains are, potentially, a disruptive technology for the design, organisation, operations, and general management of supply chains. Blockchain's ability to guarantee the reliability, traceability, and authenticity of information, along with smart contractual relationships for a trustless environment all portend a major rethinking of supply chains and supply chain management.([7] Saberi, S., Kouhizadeh, M., Sarkis, J., & Shen, L. (2019))

How blockchain functions within the context of the supply chain are still open to interpretation and development. Unlike bitcoin and other financial blockchain applications, which may be public; blockchain-based supply chain networks may require a closed, private, permissioned blockchain with multiple, limited players. But, the door may still be open for a more public set of relationships. Privacy level determination is one of the initial decisions

Four major entities play roles in blockchain-based supply chains; some not seen in traditional supply chains. Registrars, who provide unique identities to actors in the network. Standards organisations, who define standards schemes, such as Fairtrade for sustainable supply chains or blockchain policies and technological requirements. Certifiers, who provide certifications to actors for supply chain network participation. Actors, including manufacturers, retailers, and customers, that must be certified by a registered auditor or certifier to maintain the system trust

The blockchain technology can highlight and detail at least five key product dimensions: the nature (what it is), the quality (how it is), the quantity (how much of it there is), the location (where it is) and the ownership (who owns it at any moment). In this way, the blockchain removes the need for a trusted central

organisation that operates and maintains this system and allows customers to inspect the uninterrupted chain of custody and transactions from the raw materials to the end sale. This information is recorded in ledgers as transactions occur on these multiple blockchain information dimensions; with verifiable updates

([7] Saberi, S., Kouhizadeh, M., Sarkis, J., & Shen, L. (2019))Blockchain reliability and transparency are meant to more effectively facilitate material and information flow through the supply chain; with automated governance requirements. This transformation may result in a broader shift from an industrial durable, commodity, products economy to an information, customisation economy. Production will rely more heavily on knowledge, communication, and information and not necessarily on materials characteristics

Blockchain technologies have the capacity and flexibility to be applied to different SCM contexts. For instance, tracking and providing visibility through the entire supply chain optimises the information flow and generates cost reduction. In this context,([8] Queiroz, M. M., Telles, R., & Bonilla, S. H. (2019).) proposed an interesting framework based on blockchains to support peer-to-peer shipment-tracking information for suppliers and customers to improve the supply chain physicaldistribution visibility. Another important example of blockchain–SCM integration was found in the pharmaceutical supply chain. [8] Queiroz, M. M., Telles, R., & Bonilla, S. H. (2019), concluded that blockchains could improve the supply chain information sharing, making SCM more trustworthy and secure

Consequently, it could strengthen procedures for detecting fake medicines in global trade. Blockchains offer a way to face the challenge of protecting and improving security in intelligent transportation systems . Blockchain technology can strengthen IoT and CPS security, both leading Industry-4.0 technologies, resulting in improvements in smart objects and machines security , consequently improving security in the entire supply chain. Hence, we can assert that the areas both of intelligent transportation systems and IoT/CPS in the Industry4.0 context have adopted blockchain applications to improve the SCM security.

Blockchain–SCM integration can be considered a disruptive technology that will impact the entire network from a global perspective. For example, based on our findings, disintermediation resulting from smart-contract adoption will increase in the coming years . Consequently, smart contracts will contribute to several SCM improvements such as improved responsiveness, lead-time reduction, transactioncosts reduction, increased visibility and more trust, security and

transparency in the network. Furthermore, innovative changes in goods traceability will improve network transparency, dramatically reducing the costs of monitoring processes. Therefore, the impacts will be perceived in various SCM spheres, for instance, insurance costs will be significantly mitigated. Following these traceability disruptions, the ability to combat counterfeiting and fake drugs will be significantly improved in the coming years

It is possible to affirm that blockchain–SCM integration will be disseminated both in academic and practical contexts. This study's findings suggest that there are industries with significant expertise in this integration (e.g. the electric power industry, intelligent transportation systems, healthcare systems, and CPS and IoT applications). The blockchain–SCM applications in these industries can be considered benchmarks for other industries.

Finally, future blockchain–SCM integration will transform relationships not only in business-to-business contexts, but also in business-to-customer and customer-to-customer contexts. Blockchain–SCM integration is, therefore, a cutting-edge technology that is still in its early stages. However, the disruptive effects on the supply chain are being seen already. ([8] Queiroz, M. M., Telles, R., & Bonilla, S. H. (2019).)

To evaluate blockchain-based supply chain efficiency and sufficiency to create a reliable, transparent, authentic and secure system, we have adopted the theory built based on case studies as a research strategy. Working on real cases will highlight the challenges and characteristics to be taken into consideration in order to build an efficient blockchain-based supply chain. To confirm the theoretical study, knowledge of the practical and real-world application of the blockchain in a supply chain ecosystem is needed. By theoretical study, we imply study not deployed on a large scale. ([9] Azzi, R., Chamoun, R. K., & Sokhn, M. (2019).)

Several startups have already identified the blockchain as a new paradigm that aims to enhance supply chain management. We summarize the main goal of the most prominent supply chain implementations and compare them according to the blockchain type and tracking system used. By introducing blockchain into their supply chain, these startups aimed to track, record and verify goods as well as protect them from fraud and tampering. As integrating the blockchain into the supply chain ecosystem brought significant new challenges notably on the blockchain level. To build a blockchain-based supply chain management, we need

to take into consideration not only the blockchain technology but also the reliability of collected data.To study how startups, integrate the blockchain into their supply chain ecosystem, we need to understand first their tracking system and the blockchain's role in their platforms' architecture. ([9] Azzi, R., Chamoun, R. K., & Sokhn, M. (2019).)

CHALLENGES IN ADOPTION OF BLOCKCHAIN IN SUPPLY CHAIN

It has been observed that large-scale manufacturing companies have already established the SC network for their products. The inclusion of any new technology like blockchain may lead to disrupting the existing SC and cost financially ([26]Shen et al., 2018). In most of the organizations, the implementation of BT is at the pilot stage ([27]Gupta, 2017). These organizations are facing various challenges during the adoption process of BT in SC. Researchers should focus on the challenges of the adoption of BT in SC. From the literature review, the following challenges have been identified in the adoption process of BT in SC.

Inter-organizational trust : The organizations in SC networks are dependent on each other for information, product and money flow ([28]Yadav et al., 2018). Only trustworthy relations can improve the sharing of data ([29]Lo et al., 2018). Low trust among SC members is due to the lack of transparency ([30]Wu et al., 2017). For improvement in transparency, organizations involved in SC networks are dependent on each other. The foremost challenge is to create a trust to overcome interorganizational trust in SC ahead of the adoption of BT.

Governance : In SC each stakeholder has different governance policies. It is difficult to follow the policy of a particular organization. At this point, the challenge for governance is to develop consensus for a specific transaction ([31]Singh and Teng, 2016) by establishing trust among various parties in SC network ([32]Wang et al., 2018); that adds a great value to traceability and visibility ensuring product genuineness and legality.

Transparency : Compromise between data transparency and confidentiality is one of the foremost tasks in business: cooperation versus competition ([33]Wang and Kogan, 2018). SC parties resist the transparency to shield sensitive data ([34]Wang et al., 2019). In the manufacturing sector, confidentiality should be maintained about sensitive data, concurrently transparency brings marketing and branding that makes adoption of BT a significant challenge to balance between transparency and confidentiality of data.

Immutability : In BT, all the transactions are timestamped, and it cannot be changed once recorded, preventing SC activities from tampering and fraud ([35]Lee and Pilkington, 2017). The immutability of data is highly dependent upon the coding of smart contracts in SC transactions. Bad coding leads to risk the tamperproof feature of BT ([36]Cole et al., 2019). Consequently, it is a further challenge to build a code of BT that fulfills the immutability of SC

Exchange of information : All the members of SC work in a complex environment that deals with a variety of rules, principles and establishments ([37]Hull, 2017). Most of the organizations resist the use of BT in SC to uphold their privacy. In such a situation, achieving full interoperability is rely upon the trust between two organizations to share the information without third party involvement ([34]Wang et al., 2019). In the adoption of BT in SC, participants have an intricate task to identify a path to attain interoperability.

Selection of product : The function of BT in SC of the manufacturing industry varies with the product type. There is an enormous level of variation with different product types to transport and finance ([37]Hull, 2017). To develop sustainable BT-SC, product type plays a noteworthy role ([38]Kshetri, 2018). The selection of product type should be such that it should be capable of recovering the investment of blockchain and earn the profit.

Societal change : The adoption of BT in SC affects the people involved throughout SC of the manufacturing industry. Here, the biggest challenge is the social resistance and attitude of working people ([39]Yadav et al., 2019b). There

is doubt about the social and environmental sustainability of BT in SC due to cultural change from the traditional approach to BT. BT transforms the relationship between the consumers and organizations as well as inter-organizational relations to increase the acceptability of BT in SC ([40]Queiroz and FossoWamba, 2019). Without third-party validation, the origin of the product can be validated, as all the transactions recorded are timestamped and tamperproof ([32]Wang et al., 2018). Thus, blockchain forms a reliable network among all stakeholders of SC. Maintaining such a complex network requires a high level of energy, which a great concern to the social environment ([38]Kshetri, 2018).

Behavior of participant : The attitude of people participating in SC plays a significant role in the adoption of BT in the traditional SC process. Favor or disfavor of change in SC due to BT depends on people's ability to learn and accept these new changes. Behavioral intention, whether positive or negative, plays a substantial role in such a changing condition. Behavioral intention is the people's feelings about the usefulness of BT in SC ([41]Kamble et al., 2018). The adoption of BT is a revolutionary paradigm shift in SC, which requires imparting skills to the personnel to change their mindset and become professional ([40]Queiroz and FossoWamba, 2019). The behavioral intention of all the SC stakeholders will change with time and experience to increase the confidence and adopt the use of BT. Present SC is mainly relying on the third party for financial and document transactions at the expense of security, time and money ([42]Litke et al., 2019). Sectors such as food, pharmaceutical and automobile have a centralized SC system, which may suffer from counterfeiting attacks like modification of product details on a tag, cloning of a genuine product's details ([27]Gupta, 2017). Also, SC has inadequate storage for authentic data and may have a threat of single-point failure ([43]Mackey and Nayyar, 2017). The features like immutability, traceability and transparency widen the scope of BT in various sectors. The generic challenges identified in this study can be overcome by practitioners before the adoption of BT in SC of various engineering sectors. It is implied from the literature review that the adoption of BT in manufacturing industries is facing many challenges that are restraining industries from investing and exploring novel applications in their SC transactions. Some lacunas identified from literature are perceived lack of trust among the stakeholders of SC, the formation of new governing policies while replacing the existing established policies, creation of hack-proof SC network for part traceability, happening of cross-organizational communication about product/service information and inadequate knowledge of

BT that resists the changes in existing social and working culture of participants of SC of manufacturing organizations. In complex SC, it is challenging to trace products and at times it may take several days to make financial transactions. However, by using BT in SC, these issues can be resolved. As blockchain is a growing nature of technology, all the challenges in the adoption of BT in SC should be surmounted by the planned efforts of practitioners. The strategy should focus on analyzing the identified challenging factors that would be considered while adopting BT in SC of a particular organization. The objective of this research is to explore the challenges in the adoption of BT in SC. It will facilitate tracking the products in SC with smooth information and financial transaction. It is seen from the study that all the challenges in the adoption of BT in SC are inter-dependent on each other. Hence, it is necessary to interpret their interdependency based on industry practitioners' and researchers' opinions using ISM methodology

How Does Blockchain Optimize SCM?

Data consolidation and visibility

- Challenges: Manual, paper-based record-keeping and reporting systems often lead to scattered, incomplete, and unauthentic manifests, bills of lading, certifications, etc.
- Opportunities: With blockchain record-keeping solutions, all supply chain stakeholders can store and share this information securely and simultaneously.

Traceability, transparency, and trust

- Challenges: It is always challenging to track the source of flawed parts and trace the provenance of previously shipped products.
- Opportunities**:** Blockchain SCM can have a product's entire geographic flow. It enables users to track products' source and flawed components, investigate industry certifications, find storage-condition anomalies, etc

Real-time issue resolution

- Challenges: Natural disasters and unplanned demand and supply often lead to faulty or delayed delivery, which affects the entire production.
- Opportunities: The delays involving weather or labor disputes are nearly unavoidable. However, blockchain-based SCM can provide solutions to resolve these issues in real-time. As per the occurred issue, it can instantly trigger actions like supplier substitutions or price adjustments.

Blockchain is the Solution, But What are the Underlying Issues in Supply Chain Management?

Supply Chain Challenges and Blockchain Solutions :-

Establishing Trust and Maintaining Integrity

- Supply chains generally have many participants. So, having trust in such huge and complex supply chains with many members is often an issue. Moreover, it can hamper the smoothness of operations across the supply chain, too.

Also, it can harm the reputation of the supply chain companies involved in the whole process.

- For instance, when manufacturers share products with suppliers, they must follow the factory safety standards. This brings the factor of trust between the suppliers and producers. Also, trust plays a vital role in following regulatory compliance like custom enforcers.
- But, the immutable nature of Blockchain helps in reducing tampering. This also leads to establishing trust between the different participants. Further, Blockchain has the potential to connect different ledgers and data points in a better manner. This helps in maintaining the data integrity among the participants.

Reduction of Unwanted Costs

- Blockchain helps in real-time tracking of a product in a supply chain. Thus, it reduces the overall cost of moving items through a supply chain. In fact, as per a recent survey, more than one-third of people agreed that the reduction of costs is the best benefit of Blockchain for Supply Chain Management.
- Not only does it speed up administrative processes but also guarantees the security of transactions in supply chains. Moreover, the removal of intermediaries in the supply chain helps to get rid of any potential risk of fraud. It also reduces manufacturing and circulation of any fake products apart from saving money.
- Besides, the processing of payments by suppliers and customers within the supply chain will be simplified. This is because of the use of cryptocurrencies rather than depending on EDI (Electronic Data Interchange). According to a report by the Accenture, the compliance costs could drop by 30%-50% at the product level due to the improved

transparency in transactions using Blockchain. Further, it will also improve efficiency and lessen the risk of losing products with accurate record keeping

Provenance Tracking

- Keeping a track of all elements in supply chains for big companies and organizations can be tedious. Thus, it becomes very difficult to maintain the record for such multinational corporations.
- Besides, the lack of transparency can lead to a loss of money with the number of middlemen in the traditional supply chains. Also, it can dilute the brand name if any customer relations issues occur.
- However, in a Blockchain-based Supply Chain Management, these issues don't exist. This is because of the embedded sensors and RFID tags that make tracking much easier. So, product information can be easily accessed.
- Also, record keeping and data provenance tracking become easy. In fact, anyone from the supply chain can trace the history of any product from its origin to its destination, through Blockchain. Such accurate tracking methods can also aid in detecting frauds in any part of the supply chain.

Benefits of Blockchain for Supply Chain Management

- **Ability to Interoperate**: Blockchain makes data more interoperable. Thus, companies can easily share information with manufacturers, suppliers, and vendors.

- **Transparency**: Blockchain helps in reducing any delays. Also, it reduces the disputes and prevents blockage of goods in the supply chain. Real-time tracking of products minimizes the chances of misplacements too.
- **Scalability**: Using Blockchain, one can access large databases from multiple locations around the world. Thus, it helps in increasing the scalability.
- **Security**: Blockchain provides high security for supply chains. Besides, it allows customization according to the data feed. Moreover, private Blockchains can allow explicit accessing of data too. Thus, parties who has permissions can access such Blockchains.
- **Eliminating Fraud**: Tow of the most vital properties of Blockchain technology include transparency and immutability. In fact, these play a huge role in eliminating frauds in the supply chain. Also, it aims at maintaining the integrity of the system.

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