Blockchain: The Power of Supply Chain 4.0

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Abstract— With the emergence of new technologies and the upcoming fourth Industrial Revolution known popularly as Industry 4.0; the factory environment's traditional methods are changing rapidly. Various ways are being implemented to incorporate these disruptive technologies in the factory environment. One such technology is Blockchain technology, which aims at integrating the heterogeneity of systems, manage the commercial transactions, and nurture the assets' traceability. Thus, this technology is currently seeking and contributing to optimizing the supply chain, which will significantly impact the global market.

Keywords— *Blockchain, Industry 4.0, Supply Chain, Security.*

I. INTRODUCTION

Smartphones or smart appliances for personal, professional, and social purposes are increasing exponentially across the globe. There is a plethora of information and data everywhere, and a large number of data is exchanged every day. However, due to this exchange over the Internet, maintaining confidentiality, privacy, and integrity has become a significant concern in Industry 4.0. Moreover, according to the surveys conducted by different agencies, nearly 60 million people are affected by identity theft, and 12 billion people's records are misused in 2018 and expected to increase to 33 billion by 2023.
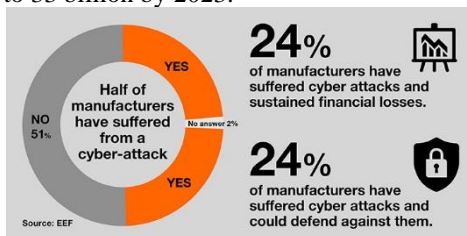

Figure 1. Smart Contract

In today's world, where technology plays a cardinal role in almost all sectors, much research is promoted for various technology applications in the industry sector. Different types of technologies are implemented to perform different functions to implement the supply chain, maintain quality, improve production, optimize the energy used, etc.

The traditional supply chain involves gathering raw materials, acquiring necessary materials, manufacturing the product, distributing, and selling it to the end-user. In the traditional supply chain, the flow of information is linear from one end to another. There is limited coaction and transparency.
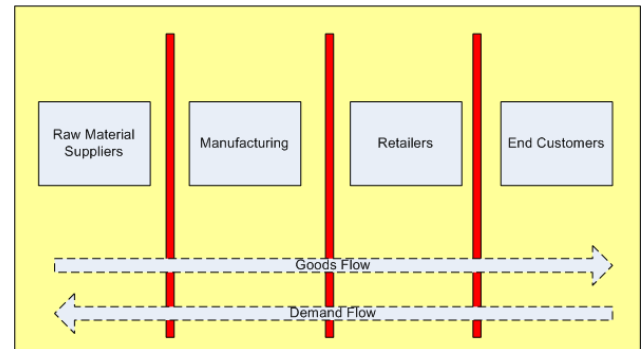

Figure 2. Traditional supply chain network

II. LITERATURE REVIEW

The Internet, new emerging technologies, and e-Commerce are leading and drastically changing the fourth industrial revolution. The supply chain has been digitized in this revolution's realms, and Blockchain lies at the core of this infrastructure.

Currently, powerful Blockchain applications and readily available AI technologies have paved the way for the next supply chain era. The physical and virtual world's unification into cyber-physical systems has a disruptive impact on every business domain and industry sector.

LITERATURE SURVEY

[1] "When Blockchain meets Supply Chain: A Systematic Literature Review on current Development and Potential Applications."
In this paper, the main focus is on supply chain management from a blockchain and smart contract perspective.

[2] "The impact of Blockchain on supply chain: a theory-based research framework and call for action."
This paper aims to diminish the current gap pertaining to blockchain technology's potential significances for supply chain management.

[3] "Applications of Blockchain to improve supply chain Traceability."
This research paper focuses on blockchain technology's impact on supply chain traceability through the present industry applications and future directions.

III. PRELIMINARIES

Define abbreviations and acronyms the first time they are used in the text, even after they have been defined in the abstract. Abbreviations such as IEEE, SI, MKS, CGS, sc, dc, and rms do not have to be defined. Do not use abbreviations in the title or heads unless they are unavoidable.

A. Supply Chain Management

Supply chain management is the management of supply chain activities: planning, manufacturing, inventory, operations, etc. to maximize the customer value and strive for competitive advantage. It usually deals with the flow of goods and services that take place right from gathering the raw products to manufacturing and selling the product to the end user. In the current scenario, supply chains are centralized and have central single link to manage the entire process.

Supply chains usually consists of all the individuals, organizations, activities that take place throughout the process, resource required and the technologies used to ease the process.

Figure 3. Supply chain management

B. Blockchain

Figure 4. Bitcoin

Nakamoto put forth the concept of Blockchain, and it supported a decentralized currency system. Decentralization refers to peer-to-peer transactions or exchanges with centralized authority. This innovation marks a breakthrough as it eliminates the heavy dependency on third-party networks. Blockchain technology is based on Bitcoin currency, which in simple terms, is a list of growing blocks that are governed by a 'ledger.' A ledger keeps a duplicate record of all encrypted transactional data that is stored in

these blocks. This ledger system being distributed in nature, benefits, and proves most favorable as it resolves the issue of information exposure and accountability. It facilitates the transparency and visibility of business activities. [1]
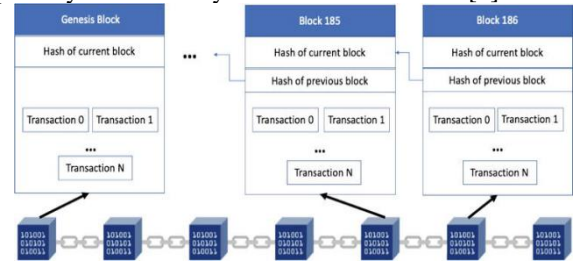

Figure 5. Chained architecture of blockchain

In terms of the supply chain, such a decentralized system would lay the foundation of trust because of the absence of centralized authority and intermediation. Furthermore, Blockchain can also record the ownership of assets, activity logs, etc., improving traceability of process flows. It will also enable the tracking of products and services. Different types of blockchain may serve other purposes in Industry 4.0 and make it more productive and efficient.

C. Smart Contract

Figure 6. Smart Contract

Smart contracts are terms and conditions that are decided between the buyer and the seller. These terms are directly written in the lines of code and self-execute when terms and conditions are met. These smart contacts streamline the complex process involving various intermediation.

Now let us look at this through the supply chain perspective. Let us assume customer A wants to buy something from seller B. Customer A will put the funds required to purchase an item from seller B in an escrow. Seller B will initiate this shipment, and when customer A receives the item, the money in the escrow will be released to the seller, whereas, if the shipment is not received, the money will be returned to the customer. When an item is sold, the manufacturer is notified to produce more for a similar item to keep up with the demand. All of this happens automatically.

Advantages:
- High speed and accuracy: The terms are automatically executed when conditions are met. Thus, the speed is high. All terms and agreements

are written in terms of code, which assures accuracy and an efficient way to store the information.

- Trust and Transparency: Smart contracts are completely visible to everyone who participates in the transaction.
- Security: Smart contracts are encrypted and stored on distributed nodes making it secure.
- Savings: Reduces the intermediaries and the cost by cutting intermediate processes.

IV. COMPONENTS

The blockchain infrastructure supported by Internet-of-Things (IoT) can digitize and transform the entire supply chain. [6]
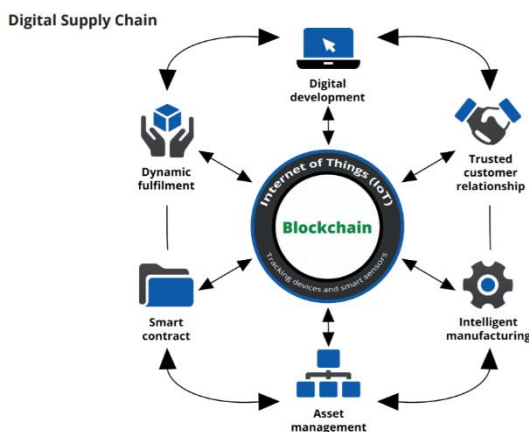

Figure 7. Digital supply chain

V. METHODOLOGY

An incremental approach would prove most fruitful and fulfilling to the companies looking to integrate Blockchain and IoT in the supply chain. The following methodology needs to be adapted to ensure promising results [2]:

1. **Know your supply chain**: Understand and study the existing supply chain. Note down the weaknesses and strengths of your supply chain.
2. **Identify Risks:** Review your supply chain at a higher level and understand the weaknesses and the possible risks you might face.
3. **Classification:** Classify the risks and weaknesses according to their function and impact and according to their nature. Jot down bottlenecks and issues in your existing supply chain.
4. **Assess:** Study how blockchain and IoT can help overcome these issues.
5. **Start small:** Choose a small scope that would incur minimum costs and experiment with these technologies to better existing issues.
6. **Trial and error:** Try until you reach a good and sustainable solution to the issue.

7. **Collaborate:** Collaborate and engage your supply network, and customers, technologists and advisors having an external view.
8. **Scale progressively:** Broaden your scope and integrate the new technology as far as possible to implement a value-driven supply chain.

Supply chains are very complex today, and they involve many participants. The most common issue faced by existing supply chains is the lack of traceability and security. Blockchain offers the best solutions to these issues and hence proves to be a powerful asset. There are numerous benefits of implementing and integrating blockchain technology in the supply chain.

VI. ADVANTAGES

A. Decentralization

The power of Blockchain lies in its very core concept of Decentralization [3]. This concept puts forth the idea that the information stored inside the blockchain is not owned by a single entity but shared by all the participants in a network. The current supply chain has major issues as it is centralized and is inadvertently owned by suppliers and procurement officers. Thus, there is no assurance that the information we get is authentic or not. Blockchain helps in breaking down this system, where the central entity manages everything. When all the supply chain entities are connected, there is no data isolation, and the data is visible to everyone that shares the network.
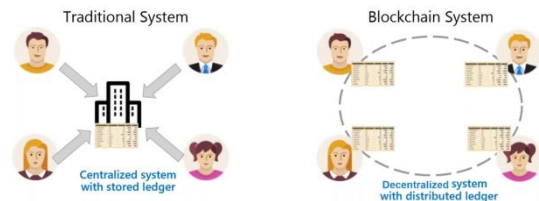

Figure 8. Decentralized system

B. Immutability

Immutability suggests the permanence of data. No data put inside a blockchain can be tampered with or changed. This quality of blockchain is very significant for supply chains. This keeps data integrity and financial data intact and secure. Blockchain inherits this function because of the use of the cryptographic hash function. Hashing enables you to take an input string of any length and outputs it in fixed length. Thus, the transactional data is taken as input, and a fixed-length has key produced as output, which can enable a user to keep track of his transaction. A small change in this hash value reflects a huge change in the blockchain structure since blocks are connected. Thus, data cannot tamper.
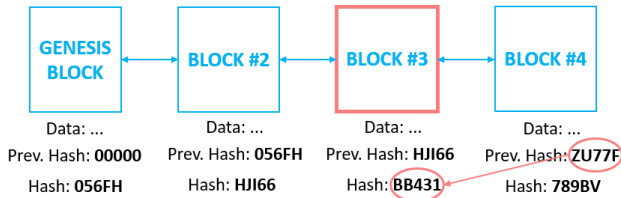
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Figure 9. Immutability in Blockchain

C. Transparency

A user's identity is encrypted and secure, while all the transactions are visible in a blockchain. Thus, financial transparency is established in the system. Thus, accountability is added to the system. The public address of the users involved is visible to all the participants, and you can check all of the transactions when you know a public address. Thus, this transparency forces one to be accountable and honest about the transactions. Every transaction that will occur in the supply chain can be visible to all the supply chain participants. This helps in maintaining trust, authenticity, and accountability.

Figure 10. Transparency in Blockchain

VII.   CHALLENGES

Although blockchain technology offers a promising solution to transform the supply chain, a few constraints need to be overcome. A more comprehensive evaluation must address these challenges and pave the way to seamlessly integrate the blockchain and supply chain.

A. Performance

Due to blockchain's decentralized nature, any transaction needs to be approved by the majority of nodes or all nodes present on that network. Thus, the computational performance required is very high to approve and process these transactions. A public blockchain may process transactions limited to 30. But integrating this technology in the supply chain requires it to process thousands of transactions per second. Thus, full scalability needs to be achieved for better throughput and efficient performance. However, a private blockchain network may suffice this need and improve the ability to process the transactions.

B. Standarization

A data standard needs to be established and agreed upon by entire supply chain participants. However, no content or format is available that can be adapted to fulfill this purpose. A lot of research has been going on to fill up this gap; however, an accepted solution does not exist as of yet.

C. Data Privacy

Data stored in the blockchain is immutable and cannot be changed, this raises a concern for data privacy. There is a need to conserve the user's privacy in an open blockchain network, which becomes challenging.

VIII.   RESULTS

The integration of the Blockchain and supply chain is still a new concept and needs to be explored for seamless and efficient working.[4] Supply chain managers and teams need to accustom themselves to this technology and incorporate it according to the methodology suggested above. Likewise, IT professionals working in blockchain technology need to upgrade their understanding of the supply chain and strive to optimize the entire process.

IX.   CONCULSION

Blockchain can transform supply chains and industry ecosystems. This transformation will not have over-night; however, this transformation will mark the breakthrough and initiate a new era of supply chains. There is a significant room in the industry sector to improve end-to-end traceability, secure transactions, speed delivery, etc. New doors can open to a more reliable, intelligent, and secure supply chain when integrated with blockchain.

X.   FUTURE SCOPE

Blockchain is now gaining momentum and having a disruptive impact on the entire industry ecosystem. Blockchain benefits greatly from the network, and companies should pay attention to the timely development of blockchain-driven supply chain.

ACKNOWLEDGMENT

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