

# A Survey of Blockchain Technology used in Supply Chain Management

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**Abstract-** Blockchain provides us the absolute privacy which indeed a hard thing Nowadays. Many corporations and venture capitalists are developing new crypto-currency technology, smart contracts and distributed ledgers for supply chain management systems. A blockchain network validates data-driven transactions while also preventing the incorporation of unauthorized transactions. Blockchains are currently non-sharable. There is no need of third party to have the validation or the certification. Participants in the blockchain need not be known each other. A blockchain network which carries out its function automatically through a process which is historically called “mining” or “forging”. This process generally involves bundling the transactions which have come into the system during an established time, along with other parameters into a block of transaction and other data which is then placed into the chain of blocks. A Blockchain client allows nodes on the network to have cryptographic verifiability over the data and state changes entered into the network out of box.

**Key Words:** Blockchain Technology (BCT), Crypto-currency, Bitcoin, Supply Chain Management (SCM), Distributed Ledger Technology (DLT).

## I.INTRODUCTION

### BLOCKCHAIN

Blockchain is rapidly becoming the most important technological advancements of the past several decades. This makes anonymous, peer-to-peer transactions between users possible and is the foundation of the crypto currency revolution. It provides us the absolute privacy which indeed a hard thing Nowadays. Many corporations and venture capitalists are developing new crypto currency technology, smart contracts, and distributed ledgers for supply chain management systems.

A blockchain is a public ledger of all bitcoin transactions that have ever been executed. A block is the current part of a blockchain which records some or all of the recent transactions, and once completed, goes into the blockchain as permanent database. Each time a block gets completed, a new block is generated. Blocks are linked to each other like a chain in proper linear, order with every block containing a hash of the previous block. To use conventional banking as an analogy, the blockchain is like a full history of banking transactions. Bitcoin transactions are entered in a blockchain just the way bank transactions are while, blocks, are like individual bank statements. The full copy of the blockchain has records of every bitcoin transaction ever executed. It can thus provide insight about facts like how much value belonged to a particular address at any point in the past. Some

developers have begun looking at the creation of other different blockchains as they do not believe on depending on a single blockchain. Parallel blockchains and side chains allow improved scalability using completely independent blockchains, thus allowing for more innovation.

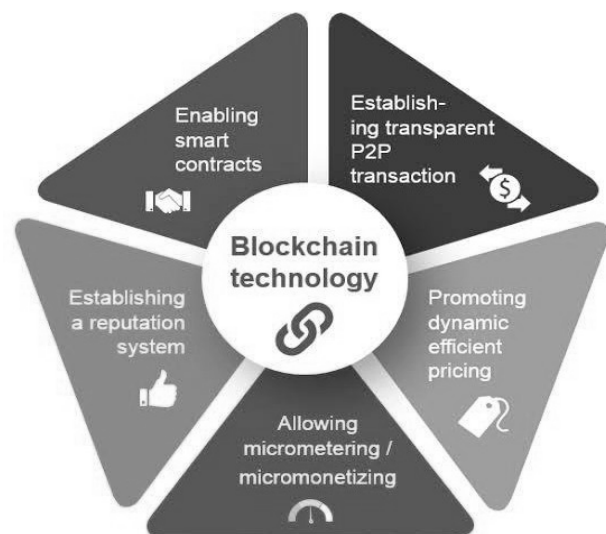


Figure 1.1Blockchain

## THE HISTORY OF BLOCKCHAIN TECHNOLOGY

The first work on blockchain was described in 1991 by Stuart Haber and W.Scott Stornetta. In 1992, Bayer, Haber and Stornetta incorporated Merkle trees to the design, which improved its efficiency by allowing several document certificates to be collected into one block.

The first blockchain was conceptualized by Satoshi Nakamoto in 2008. Nakamoto improved to timestamp blocks without signed by a trusted party added to the chain. The design was implemented by Nakamoto as a core component of the crypto currency bitcoin, where it serves as the public ledger for all transactions on the network.

In August 2014, the bitcoin blockchain file size, of all transactions reached 20 GB. January 2016 to January 2017, the bitcoin blockchain grew from 50 GB to 100 GB in size. A smart contract that runs on a blockchain, which allows to share the certificates that automatically if profits reach a certain level. It require an off-chain oracle to access any external data or events based on time or market conditions that need to interact with the blockchain.

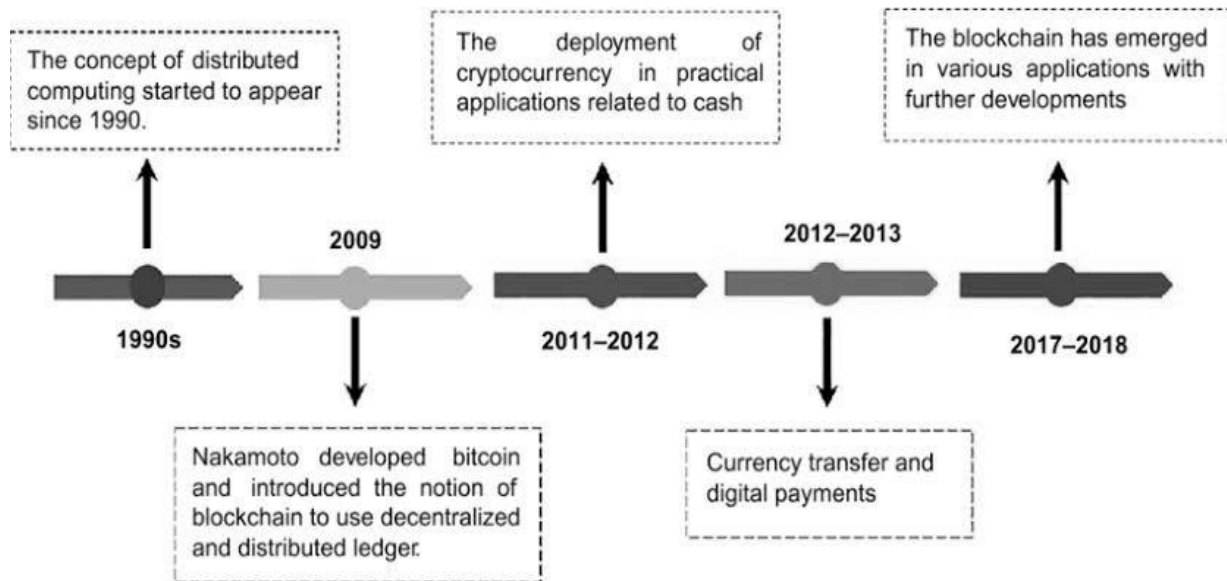


Figure 1.2 History of Blockchain

## II. BLOCKCHAIN TECHNOLOGY

Blockchain has been one of the most awe-inspiring innovations since the Internet came into existence. Blockchain technology basically allows everyone to hold and make transactions as strangers but in a completely transparent manner. There is no mediator in between two people making the transaction, and the entire process becomes easier and cheaper. This concept can be applied to the entire digital world making any kind of exchange/transactions secure and not just bitcoin. This article will take you through numerous such business models and companies that are beginning to sprout based on blockchain tech.

The blockchain network consists of nodes, i.e., distributed servers. All the nodes can accept and process the transaction. The nodes on the network share information about the candidate transaction. As much as the logic/tech part of it sounds confusing, the business models are so much easier to understand and are really impressive.

What you have already seen is that blockchain distributed ledger is an in-erasable record of bitcoin transactions. The network of computers around the world running bitcoin software will take care of the performance and maintenance of the blockchain network. About six times per hour, a new group of accepted transactions a block is created, added to the blockchain and quickly published to all nodes. This allows bitcoin software to determine when a particular bitcoin amount has been spent. It is this feature of Blockchain technology that has grown in its popularity amongst large banks, developers and entrepreneurs.

### CHARACTERISTICS OF BLOCKCHAIN

A blockchain network is a software network comprised of a set of users running a blockchain client. All of the blockchain clients in a given blockchain network are connected together so that they are collectively building and also interacting with a single authoritative ledger. When we discuss the characteristics of a blockchain we

are really discussing three different things:

1. Blockchain Network
2. Blockchain Client
3. Blockchain ledger.

Blockchain ledgers are simply a record of transactions which have been broken into blocks and linked together using cryptographic digital signatures. It is the blockchain network and blockchain clients which are much more interesting. There are three areas where both blockchain networks and blockchain clients stand out from their process management solutions available to organizations:

- Blockchain clients and networks validate everything
- Blockchain clients are highly independent
- Blockchain clients and networks are automated

### LET'S LOOK AT SOME OF THESE CHARACTERISTICS

Mining or forging Within a Blockchain Network and Blockchain Clients. A blockchain network carries out its functions automatically, through a process which is historically called "mining" or "forging". This process generally involves bundling the transactions which have come into the system during an established time, along with other parameters into a block of transactions and other data which is then placed into the chain of blocks. Blockchain clients allow nodes on the network to have cryptographic verifiability over the data and state changes entered into the network out of the box.

This level of verifiability can be added to a non-blockchain based database back end. The difference being whether the cryptographic certainty is a first class citizen of the network or whether it is an add-on is likely irrelevant for many applications. Most modern databases store the world state of the data and keep the

logs of transactions with the database as a separate “thing”. Blockchain clients, on the other hand, build the world state of the data from the blocks of authenticated transactions that are “chained” together over time. Thus it is always immediately possible to tell if something is valid, as it must have come from a valid history, and everyone agrees completely on the sequence of valid history.

### III. TYPES OF BLOCKCHAIN

#### 1. Public blockchain

A public blockchain is a platform where anyone on the platform would be able to read or write to the platform. There has been a lot of activity in this space as the number of potential users that any technology in this space could generate is high. Also, a public blockchain is considered to be a fully decentralized blockchain.

**Ethereum** Launched in 2015, Ethereum is the world’s leading programmable blockchain. Ethereum is maintained and improved over time by a diverse global community of contributors who work on everything from the core protocol to consumer applications.

This website, just like the rest of Ethereum, was built - and continues to be built - by a collection of people working together. a provider of a decentralized platform and programming language that helps running smart contracts and allows developers to publish distributed applications.

**Factom**, The public Factom blockchain is governed by a peer-to-peer network of federated servers whose membership is based on performance and community support. Anyone can read entries and submit write requests for a fixed cost based on chain and entry size.

The Factom protocol is open source and anyone can run a follower node or create a private network for development and production use cases. Factom is simply a provider of records management, records business processes for business and governments.

**Blockstream**, a provider of sidechain technology, focused on extending capabilities of bitcoin. The company has started experimenting on providing accounting with the use of public blockchain technology.

Blockstream’s mission is to create the financial infrastructure of the future.

It build crypto-financial infrastructure based on Bitcoin, the most robust and secure blockchain. Applying cutting-edge cryptography and security engineering, they are building the products and networks that make financial markets more efficient by reducing reliance on trust. With a long term outlook on delivering robust and scalable solutions, we invest heavily in research and development to strengthen the Bitcoin ecosystem and protocol. Peer-to-peer, open network finance holds the promise to change the world for the benefit of all.

#### 2. Hybrid blockchain or consortium blockchain

A hybrid blockchain has a combination of both public blockchain and private blockchain. The exact workings with restricted access work on their solutions and maintain the intellectual property rights within the consortium.

#### 3. Private blockchain

A private blockchain, on the other hand, allows only the owner to have the rights on any changes that have to be done. This could be seen as a similar version to the existing infrastructure wherein the owner or a centralized authority would have the power to change the rules, revert transactions, etc. based on the need. It could find use cases to build proprietary systems and reduce the costs while at the same time, increase their efficiency. Simply a private blockchain is permissioned. One cannot join it unless invited by the network administrators. Participant and validator access is restricted.

**Eris Industries** aims to be the provider of shared software database using blockchain technology.

**Blockstack** aims to provide financial institutions back office operations, including clearing & settlement on a private blockchain.

**Multichain**, provides an open source distributed database for financial transactions. Chain Inc., a provider of blockchain APIs. Chain partnered with Nasdaq OMX Group Inc., to provide a platform that enables trading private company shares with the blockchain.

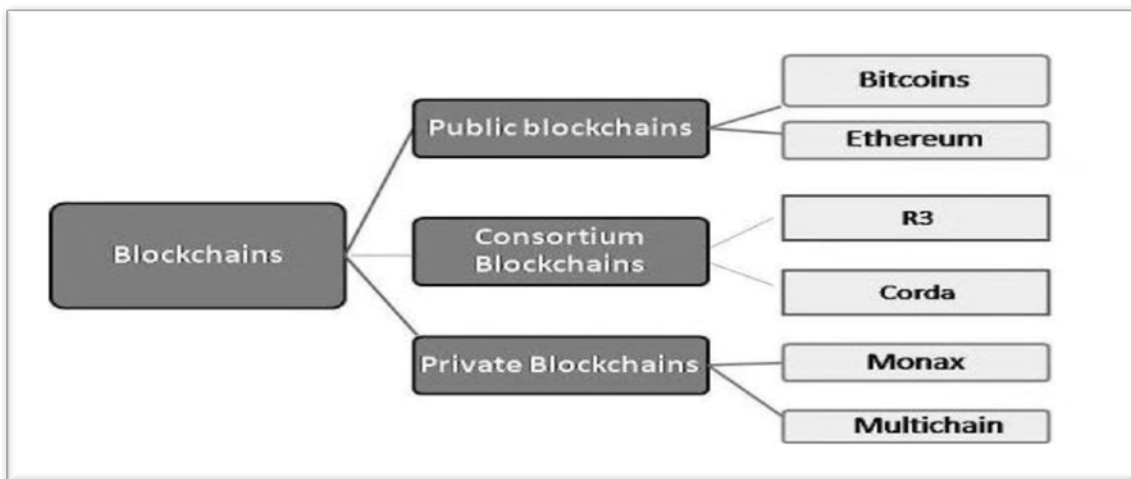


Figure 3.1 Types of Blockchain

## COMPARISONS OF BLOCKCHAIN TECHNOLOGY

	Public Blockchain	Private blockchain	Federated/Consortium Blockchain
Access	<ul style="list-style-type: none"> <li>• Anyone</li> </ul>	<ul style="list-style-type: none"> <li>• Single Organization</li> </ul>	<ul style="list-style-type: none"> <li>• Multiple selected organizations</li> </ul>
Participants	<ul style="list-style-type: none"> <li>• Permissionless</li> <li>• Anonymous</li> </ul>	<ul style="list-style-type: none"> <li>• Permissioned</li> <li>• Known identities</li> </ul>	<ul style="list-style-type: none"> <li>• Permissioned</li> <li>• Known identities</li> </ul>
Security	<ul style="list-style-type: none"> <li>• Consensus mechanism</li> <li>• Proof of work/ Proof of Stake</li> </ul>	<ul style="list-style-type: none"> <li>• Pre-approved participants</li> <li>• Voting/ multi-party consensus</li> </ul>	<ul style="list-style-type: none"> <li>• Pre-approved participants</li> <li>• Voting/ multi-party consensus</li> </ul>
Transaction Speed	<ul style="list-style-type: none"> <li>• Slow</li> </ul>	<ul style="list-style-type: none"> <li>• Lighter and faster</li> </ul>	<ul style="list-style-type: none"> <li>• Lighter and faster</li> </ul>

**Table: 3.1** Comparisons of Blockchain Technology

## AUTOMATION WITHIN A BLOCKCHAIN NETWORK AND BLOCKCHAIN CLIENTS

A blockchain network validates data-driven transactions while also preventing the incorporation of unauthorized transactions. Blockchains are currently non-shareable. This is a very important difference between blockchain and hub and spoke database architecture.

While this may seem like overkill, it should be noted that it is significantly easier to run blockchain clients in a cloud manner than the hub and spoke databases. If you need the data management solution to be easily spun up and distributed amongst nodes which are not fully integrated into infrastructure of the data management solution then blockchain architecture is likely an appealing data management solution.

## ADVANTAGES OF USING BLOCKCHAIN

- As a public ledger system, blockchain records and validate each and every transaction made, which makes it secure and reliable.
- All the transactions made are authorized by miners, which makes the transactions immutable and prevent it from the threat of hacking.
- Blockchain technology discards the need of any third-party or central authority for peer- to-peer transactions.
- Decentralization of the technology.

When abstracting a blockchain network to a certain level is a distributed, self-authenticating, time-stamped store of data. Indeed, the core design of a blockchain client is an elegant way in which to overcome many challenges in distributed systems.

## IV. APPLICATIONS OF BLOCKCHAIN: PRESENT AND FUTURE

**Digital Identity**

The uniqueness and security of blockchain enables its use for identity. The blocks can contain the details of an individual and the rate of identity theft will be on the decrease. Blockchain technology in identification enable the users to controls who have they data and how they can use the data. Some blockchain companies that have employed it for identification are UniqueID Wallet, Identifi, and 2Way.

**E-Voting**

The traditional paper ballot system is a very popular method of choosing leaders in a democratic system of government. This traditional ballot system has so many problems ranging from all forms of rigging which includes ballot stuffing, falsification of results, voter intimidation, the inability to track one's vote, vote buying, time wastage on queue for voting and counting of votes etc.

Although, several counties have tried the electronic voting but there are issues of security of data on a central server which can be solved by the Distributed Ledger Technology (DLT) due to its distributed and immutable nature. The decentralized and immutable nature of the Distributed Ledger Technology (DLT) enables voters to track their votes and even change their votes before a specific deadline there by making the entire process transparent.

Electronic voting (e-voting) of late has been the trending technology in democratic nations instead of manual and paper ballot or voting. However, some security issues are setback to it and the voting transaction can be tempered even though it is a real time system. To this effect, Follow My Vote platform uses blockchain technology in combination with elliptic curve cryptography to provide a secure and transparent online voting solution. Notably, NASDAQ and the Republic of Estonia in 2016 announced that Estonia's e-Residency platform will be facilitating a blockchain-based e-voting service to allow shareholders of companies listed on NASDAQ's Tallinn Stock Exchange to vote in shareholder meetings. NASDAQ's Tallinn Stock Exchange is Estonia's only regulated securities market.

**Finance**

The first application of the blockchain technology was Bitcoin, a digital currency which was based on a protocol that allows the users of the network to perform transactions with virtual money that exist only in their computers in a fast, and secure way.

Bitcoin uses peer-to-peer technology to operate with no central authority or banks; managing transactions and the issuing of bitcoins is carried out collectively by the network. Bitcoin is open-source; its design is public, nobody owns or controls Bitcoin and everyone can take part.

A blockchain is a public ledger of all Bitcoin transactions that have ever been executed. It is constantly growing as 'completed' blocks are added to it with a new set of

recordings. A block is the 'current' part of a blockchain which records some or all of the recent transactions, and once completed goes into the blockchain as permanent database which cannot be easily altered. Each time a block gets completed, a new block is generated. There is a countless number of such blocks in the blockchain. The blocks are linked to each other (like a chain) in proper linear, chronological order with every block containing a hash of the previous block.

The blockchain is seen as the main technological innovation of Bitcoin, since it stands as proof of all the transactions on the network. Each node (computer connected to the Bitcoin network using a client that performs the task validating and relaying transactions) gets a copy of the blockchain, which gets downloaded automatically upon joining the Bitcoin network. The blockchain has complete information about the addresses and their balances right from the genesis block to the most recently completed block. To use conventional banking as an analogy, the blockchain is like a full history of banking transactions. Bitcoin transactions are entered chronologically in a blockchain just the way bank transactions are. Blocks, meanwhile, are like individual bank statements which Blockchain is kept up to date with the help of cryptography and copious computing power, provided by a global network of tens of thousands of computers. Openness in the chain helps the system remain secure: the blockchain is public so every participant can check and verify whether a transfer comes from the rightful owner.

#### **Food Industry**

Distributed Ledger Technology (DLT) is currently been applied to the tractability and transparency of food production and consumption in the food industry. According to Walmart in collaboration with IBM is implementing the DTL to enable the total transparency of the food production and retail system. Hence a retailer or a consumer can trace easily the source of any food. The advantages of this food transparent system are so enormous. Some of which include the enhancement of food safety, availability of only fresh food in the open market, prevention of food wastage, avoidance of food fraud.

#### **Cyber security**

With the increase in the occurrence of cybercrimes, there is the need to secure data more efficiently in a network. The Distributed Ledger Technology (DLT) can be applied to solve the cybersecurity issues due to its immutability, the absence of human trust, decentralized and consensus traits. The consensus traits enable a democratic system for where nodes in the systems take a note to make a change in data.

#### **Property Registration in the Real Estate Sector**

In recent times, land fraud has gradually increased. With the Distributed Ledger Technology (DLT) the process of processing a land can be made transparent by making the land registration process open. Hence, investors can easily know genuine property that is in the real estate market.

#### **Healthcare**

The Distributed Ledger Technology (DLT) can be applied

in managing diseases outbreak data and for the tracking of patients' health after they have been discharged from the hospital. It can also be used to track a patient's medical record from various doctors.

#### **Banking and Financial Institutions**

The Distributed Ledger Technology (DLT) can be used in tracking financial transactions thereby checking fraud. It can also be used in making financial predictions as a result of the large amount of data and in fact, the large amount of distributed data in the Distributed Ledger Technology (DLT) is attracting interest from researchers in the field of big data analysis.

#### **Entertainment Industry**

The Distributed Ledger Technology (DLT) can be used in tracking and leasing of intellectual properties of artist such as song records, royalties, ownership of work and copy write issues in the entertainment industry.

#### **Transport and Tourism**

The Distributed Ledger Technology (DLT) can be applied to car hiring and the optimization of hotel spaces.

### **FUTURE APPLICATION OF BLOCKCHAIN**

Emerging Bank can use blockchain technology as general ledger. Blockchain technology has the ability to keep track of data like transactions, contracts, agreement and these can be also to verify, because of this potential, it can be used in asset management especially in the area of land certificate.

Blockchain Technology can make great impact in financial institutions since it can be used to keep track of details of any transaction or ownership of any asset like real estate management and intellectual property. It can also be used to automate contracts. Notable applications of Blockchain Technology may include:

- Smart contracts
- Physical asset registration (e.g. the issuance of Certificate of Occupancy)
- Trade execution and settlement
- Asset exchange
- Cash reserve management
- Supply chain management
- Stock exchange market
- Communication and social networks
- Insurance
- Education (bodies like WAEC, NECO, IELTS, TOEFL and so on)

### **V. SUPPLY CHAIN MANAGEMENT**

Supply chain management is the management of the flow of goods and services and includes all processes that transform raw materials into final products. It involves the active streamlining of a business's supply-side activities to maximize customer value and gain a competitive advantage in the marketplace. By managing the supply chain, companies are able to cut excess costs and deliver products to the consumer faster. Good supply chain management keeps companies out of the headlines and away from expensive recalls and lawsuits.

Supply chain management is a cross-functional approach that includes managing the movement of raw materials

into an organization, certain aspects of the internal processing of materials into finished goods, and the movement of finished goods out of the organization and towards the end consumer. As organizations strive to focus on core competencies and become more flexible, they reduce their ownership of raw materials sources and distribution channels. These functions are increasingly being outsourced to other firms that can perform the activities better or more cost effectively. The effect is to increase the number of organizations involved in satisfying customer demand, while reducing managerial control of daily logistics operations. Less control and more supply chain partners lead to the creation of the concept of supply chain management. The purpose of supply chain management is to improve trust and collaboration among supply-chain partners thus improving inventory visibility and the velocity of inventory movement.

**Components**

SCM components are the third element of the four-square circulation framework. The level of integration and management of a business process link is a function of the number and level of components added to the link. Consequently, adding more management components or increasing the level of each component can increase the level of integration of the business process link.

- Planning and control
- Work structure
- Organization structure
- Product flow facility structure
- Information flow facility structure
- Management methods
- Power and leadership structure
- Risk and reward structure
- Culture and attitude

**Global applications**

Global supply chains pose challenges regarding both quantity and value. Supply and value chain trends include:

- Globalization
- Increased cross-border sourcing

- Collaboration for parts of value chain with low-cost providers
- Shared service centers for logistical and administrative functions
- Increasingly global operations, which require increasingly global coordination and planning to achieve global optimums
- Complex problems involve also mid-sized companies to an increasing degree

These trends have many benefits for manufacturers because they make possible larger lot sizes, lower taxes, and better environments (e.g., culture, infrastructure, special tax zones, or sophisticated OEM) for their products. There are many additional challenges when the scope of supply chains is global. This is because with a supply chain of a larger scope, the lead time is much longer, and because there are more issues involved, such as multiple currencies, policies, and laws. The consequent problems include different currencies and valuations in different countries, different tax laws, different trading protocols, vulnerability to natural disasters and cyber threats, and lack of transparency of cost and profit.

**Linking SCM and BCT**

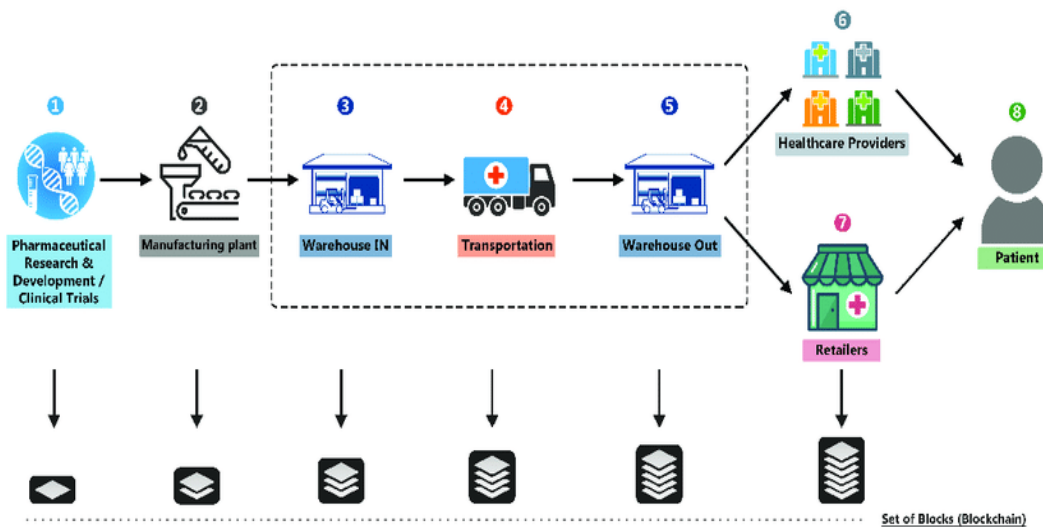
BCT provides four key features that can enhance integration and coordination among the members of a supply chain.

**Transparency,** Transparency relates to the shared ledger of information which is aggregated from various sources and participants of the blockchain.

**Validation,** Immutability of records and consensus-based verification enable validation of information.

**Automation,** Automation refers to the opportunity to execute smart contracts based on verified information on the blockchain.

**Tokenization,** BCT allows creation of tokens that represent a specific claim on any valuable asset and their exchange between blockchain members (tokenization).



**Figure 5.1** Supply chain Management in Blockchain

## VI. CONCLUSION

The main application of blockchain is cryptocurrency and bitcoin; which uses a peer-to-peer technology to carry out transaction with little or no intervention of trusted third party. With the growing adoption of digital technology for financial transactions, blockchain technology can offer a wide range of services to financial institutions which can help in good complete strategy against its competitors and increase efficiency. In the future blockchain can be adopted in Supply chain management, land certificate administration, university certificate verification, assets management. It will also serve as a strong cryptographic technology behind many Apps ranging from mobile App to Desktop App. The future of blockchain is sure, just as the internet has made the world a global village.

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