



Applications Of Blockchain Technology In Business With Special Reference To Supply Chain Management

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Abstract: Business applications of Blockchain Technology are on the rise but there is little initiative to use it to streamline supply chain operations. A review of literature and comparative analysis has been done to review how and where blockchains can be used in business, especially in management of supply chains. This study critically examines the various features of Blockchain Technology and its use to improve the transparency, efficiency, cost effectiveness and security of supply chains. Further, this study acknowledges its limitations and provides valuable insight to academicians and professionals on the areas where Blockchain Technology enhances the supply chain network.

Keywords: Blockchain Technology, Supply Chain Management, Smart Contracts, Cryptocurrency

Introduction

The term "blockchain" is derived from "the blocks" of reliable and undisputable transactions that are linked in chronological order to form a chain. This internet-based technology is best known for its capability to record, authenticate, and disburse digital transactions in encrypted and undisputable registers. Blockchain Technology was articulated to conduct transactions of Bitcoin. Bitcoin is a digital currency that works independently from banking channels. It has facilitated the means for creating and distributing the record of every bitcoin transaction using thousands of computers all around the world that are connected through the internet. All transactions in the blockchain are encrypted, hence more secure than the traditional banking network. Rapid transfer of information reduces transaction costs of money transfer and eliminates the delay caused by clearing process of banks.

Today, the applications of Blockchain Technology go further than crypto-currency and Bitcoins. The ability of blockchain to create a transparent and secure network while saving the time and cost of business operations has led to its integration with different

sectors ranging from smart contracts to tracking systems to voting mechanisms, etc. to find solutions to recurrent industry problems. The features of Blockchain Technology include decentralization, transparency, immutability and automation. These can be used in various industries and business sectors like asset tokenization, supply chain management, digital identity, energy market, healthcare, etc.

The Blockchain Model: The blockchain consists of blocks. The “Blocks” comprise of digital pieces of information and can be called as the ‘container of data structure’. The average size of a block is 1MB, can be increased to 8MB which can record up to 500 transactions on an average (for Bitcoins). The size of the block is proportional to the number of transactions processed per second. Fundamentally, a block has three components:

1. Blocks have a time- stamp which allows the links between the blocks to be formed in chronological order. A reference to the previous block in blockchain is randomly generated, called nonce, which is a 32- bit whole number.
2. Each blocks stores data about the conducted transaction using a unique ‘digital signature’ and no other identifying feature.
3. Each block stores data to differentiate it from other blocks. It has a code called a “hash” that it unique to it. A hash is a digital cryptographic code created by special algorithms. Each hash is a 256- bit number attached to the nonce.

A nonce in the block produces a cryptographic hash the first time that block is created. The information in the block is taken to be valid and attached to the nonce and hash unless new blocks are created. New blocks in the chain are added by miners who use a unique software to create and add the blocks.

The core components of Blockchain Technology are as follows:

1. Node: The node represents the user or the computer terminal used in the chain. Every node has its own copy of the complete blockchain register.
2. Block: contains the data used for recording and validating information. Linked blocks are what creates a blockchain.
3. Chain: is the sequence of blocks arranged chronologically.
4. Miner: is the specific node (user) who use special software to solve complex algorithms to create and add new blocks in the chain. They perform the block verification process.
5. Transaction: is the record of information that serves the purpose of the blockchain.
6. Blockchain Network: is the set-up under a specific situation of one or more organizations.
7. Blockchain Code: is the tasks and objectives that the blockchain is developed to accomplish
8. Linked lists: are the sequence of blocks in which each block has a unique information and links to the next block using a pointer.

9. Pointers: are variables that store data about the other variable's situation. The first block does not require a pointer.
10. Consensus Protocol: is the rules and regulations to related to blockchain operations.

How does a blockchain work? Blockchain is made up of a series of blocks linked in a particular sequence. For a new block to be added to the chain, some considerations are:

1. A transaction must occur for creation of a block. Sometimes, a block can combine a number of transactions having all related information like time, amount, quantity, etc.
2. A new transaction in the blockchain means a new block has been created which must be verified. Every record is authenticated and digitally signed to ensure its legitimacy. The block must be verified by majority of nodes in the network before it is added to the system.
3. The new transaction, secured in a block is approved and stored once the information is verified. The transaction and its details are connected with digital signature on the block. The same block can store more than one record of transactions.
4. Each block is assigned a unique identifying code called a hash. The hash is assigned in a chronological and linear order in the chain. Once the block is hashed it can be added to the network at the end of the blockchain.

When a new block is added to the chain, it is publicly visible to all nodes (in the network) and they can view the contents of the block.

Features of blockchain technology: Business industries and companies should determine whether to invest their capital in blockchain technology by focusing on the features and utility it provides along with the company's position in the industry and the market. The main features are:

Decentralized: Blockchain technology can be utilized to decentralize the web by creating a stage for enabling direct control of assets, eliminating the need of middlemen. The individual users (nodes) can transact directly for a nominal fee.

Secure and Private: Each block on the blockchain has an exclusive hash, that changes when the data on a block is changed, but the hash codes on the preceding and succeeding blocks do not change. Thus, altering information on the blockchain is difficult. Users in the chain are able to view transaction information but they cannot view or alter personal identifying information related to any user since personal information is not recorded.

Transparency: Though blockchain technology itself is almost always open, personal information on it is private. Transactions are approved by a network of user computers (data immutability), reducing chances of data entry errors by an operator and increasing accuracy of recorded information.

Consensus: Every blockchain operates on the consensus algorithms. The architecture of the blockchain is efficiently designed, and consensus algorithms are at the core of it which helps the network to make decisions and reach better settlement. Nodes are not familiar with each other, but they can trust the algorithms that run the blockchain.

Types of blockchain:

A Private Blockchain [also called Permissioned Blockchain] is useful when companies and organizations want to share data but do not want to share classified business data. This is a centralized chain controlled by the companies who control the users and create its governance structure. Participants require permission to join a specific private network. All transactions are private and available only to participants of the network. Hyper Ledger and R3 Corda are examples of private blockchains.

Public Blockchains are open source, permitting anyone to participate as a miner, user, developer, or a member of the community. Transactions here are transparent and records are accessible to all. Public blockchains are decentralized, no individual or organization has control over the transactions. It is difficult for authorities to control or close public blockchains. Two examples of public blockchains are Bitcoin and Ethereum.

Hybrid Blockchain combines the transparency & security of public blockchain with the privacy feature of a the private blockchain. It gives organizations flexibility to decide which data to be publicly visible and which data to be kept private. They also allow easy connectivity with other blockchain forming multi-chain networks of blockchains. The combined benefit of these features allows businesses to work with the transparency, without compromising their data privacy and security. An example of hybrid is Dragon chain.

Application of blockchain technology: Blockchain Technology has gained immense popularity and is transforming the methods and ways of various industries. The technology can lead to positive developments in multiple areas of business. Some of the applications are:

Digital ID: An estimated 1 billion population of the world does not have an official digital identity. Blockchain technology would help to link them with the formal financial sector through its Authenticator app. It is an alternative for users to handle their digital identities. Example- Microsoft is aiming to create digital identities of poor and refugees to empower them.

Healthcare: Privacy and security of health information are important. Blockchain technology helps in tracking the serials and batch numbers of prescription drugs of the patients and store medical records. It also gives a patient access to own health status.

Food Safety: Blockchains enable traceability of food from its origin to the end point by recording all movement as the produce moves through the supply chain from source to the market. In case of contamination, it is possible to trace where the problem occurred.

Digital Voting: Fraud in voting has been of immense concern, using blockchain in voting system can make the process more transparent and secure because of its immutability feature. Any changes made to the system will be visible to the authority. It can ensure “one unchangeable vote per person”.

Weapon Tracking: Blockchain technology would ensure that a nation’s government and law enforcement can track weapon or gun or ammunition ownership. It can act as an unchangeable and transparent registry which can also help to keep a record of weapons sold privately to individuals and organizations.

Intellectual Property Rights Protection: Copyright, patent and ownership laws on movies, music, videos, blogs, books and other online content are important in the current business world. The laws can be made secure via blockchain technology. Digital material downloads can be a good option as will ensure that the artist or the creator of the content or the parties involved in success of the content also get their due credit and monetary share. This technology would provide real-time and authentic royalty distribution information to content creators and artists.

Internet of things (IoT): Any material object that can be connected to internet and form a network is called Internet of Things (IoT). Blockchain Technology will help the users of these material objects in IoT to be aware of other individual’s activities while protecting privacy to complete work in a synchronized and efficient way.

Cryptocurrency: Blockchain is the basis for crypto-currencies. It allows expansion of operations across computer network without involvement of a formal financial authority, reducing the risks of unstable economic conditions of a country or a bank. The technology also helps to eliminate the processing and transactional costs, domestically or internationally. The users of the network also have immediate access to the information on the blockchain platform.

Smart Contracts: could be one of the important applications of Blockchain technology in coming times. Smart contracts (digital contracts) are integrated with an IFTTT (if-this-then-that) code, which makes them self-executing. Traditional contracts have a third party that ensures that all parties adhere to the terms and conditions. Digital contracting ensures that all the users are aware of the contract details and terms in the contract are automatically executed once pre-defined conditions are met. Smart contracts can be used in varied situations, such as real estate & property law, crowd funding agreements,

financial services, and insurance premiums etc. In 2013, Project Ethereum was launched to enable implementation of digital contracting.

Cloud Storage: is a popular use of Blockchain technology that businesses and companies are benefiting from. A number of private firms offer cloud storage. Storj is a company actively researching on providing a secure cloud storage to reduce hardware dependency.

Supply Chain Management: Blockchains Technology increases the overall efficiency of supply chains and its operations. Blockchain provides digital identification of the origin of raw materials & value addition as and when it occurs on the products in the supply chain. This aids in preventing losses, minimises risks and monitoring of the quality of products while in production or shipment. Using this technology will provide a manufacturing firm with digital and auditable records to show the value addition to the final product at every step in the supply chain to all stakeholders. For example, Provenance is a company actively working on countering challenges faced by traditional supply chains through blockchain technology.

Objectives of the research: This paper aims to contribute towards an understanding of the of the features and applications of Blockchain Technology in business. The work provides a summary of current blockchain technology-based system and value added operations across different sectors. Based on a systematic literature analysis approach, this paper tries to justify the need to conduct more research on uses of the blockchain technology. The main objectives are:

1. Define the Blockchain Technology: Defining the blockchain includes understanding the technical aspects and the architecture of the technology, Study the Features of Blockchain Technology and understand the value it adds to the different areas of business.
2. Systematically review available literature on Blockchain Technology in Supply Chain Management. Categorize areas and suitability of application of blockchain technology in different levels of SCM operations.
3. Classify the applications of a blockchain-enabled supply chain. Different applications of this technology are studied taking into account the limitation the technology currently possesses and the value it creates in various sectors of business

Research Methodology:

This research aimed to provide a literature review of blockchain-based applications in various fields of business, especially in supply chain management. For this a reasonable research methodology was adopted. Research methodology can be defined as a specific procedure or technique that can be used to identify, choose, process and analyze data about a particular topic or field of study. The research methodology helps to determine the credibility and viability of the research.

Research approach: This paper adopts a Descriptive Research approach. Descriptive research is applied to describe the characteristics of a population or a subject under study. It uses a number of ways to investigate and critically examine the information present to establish facts about the variables on the topic of study but does not manipulate the variables to know the cause and effect of those variables. This research provides a systematic description of the technical and functional aspects of Blockchain Technology and its business applications with focus on SCM operations with suitable examples.

SYSTEMATIC LITERATURE REVIEW: This research is done via a comprehensive literature review already present on the topic Blockchain Technology from different academic and practical databases, articles and papers published in recent years. Knowledge generation within the different fields of business research is accelerating at a rapid speed and simultaneously remains fragmented and interdisciplinary. This makes it very difficult to keep up with state-of-the-art technologies and up gradation and to remain at the forefront of research, as well as to assess all the information in a particular area of business research. This is why the systematic literature review as research methodology is more relevant in this paper as the applications of Blockchain Technology are being studied in various fields of business so that the implementation and integration of this technology in the said fields is seamless.

Review of literature:

Nakamoto (2008) described Blockchain Technology as a distributed Peer-to-Peer network, which could be used to maintain the order of transactions and to avoid the double-spending problem. Further, this technology was applied in creation of a new digital currency called Bitcoin. In 2009, the Bitcoin network went live and gained immense popularity because of its value development.

Bitcoin records transactions in blocks, grouping the blocks in a sequence in a limited-size structure with same timestamp. The nodes (miners) in its network create a chain of blocks by linking blocks in a chronological order. Each block is linked to the previous block by a hash – creating a chain of blocks called the blockchain (Crosby, 2016). This way the blockchain network keeps a registry of all transactions.

Application of blockchain in traditional business caused disruption since a number of business applications and transactions that were dependent on centralised systems or a third party for verification could now be accomplished in a de-centralised manner with the same level of certainty (Greenspan, 2015). The uniqueness of blockchain design and composition delivers advantages like transparency, security, consensus and immutability. This technology is highly suitable for the banking sector as a bank can have its own blockchain and validate the transactions of their customers. The blockchain promotes transparency and facilitates auditing of transactions. A number of companies have gone ahead with this technology due to its features like digital decentralization of business architecture, reduction in transaction costs that are faster, secure & transparent. (Chrsitidis and Devetkiostis, 2016).

The consensus mechanism of the blockchain network ensures that verification for the data updated by the users is working fine (Gipp and Zyskind, 2015). Because of its many useful features, blockchain technology is becoming increasingly relevant in all spheres of business fields (Nakamoto, 2008). Business researchers, developers and experts are aware of the capability blockchains and research on its application in a variety of business and industry sectors is on the rise (Zhao, 2016). Depending on the targeted users, following are three generations of blockchain technology:

- Blockchain 1.0 facilitates digital/crypto-currency exchanges;
- Blockchain 2.0 is application of blockchain beyond cryptocurrency transactions, including supply chains;
- Blockchain 3.0 are the usage in areas other than mentioned above such as Internet of Things, government, healthcare, science, and energy market.

The term 'smart contract' came into being in 1993, gaining recognition in recent times due to blockchain technology. In 2013, Ethereum project was initiated. Ethereum is described as a decentralized platform that runs smart contracts: applications that run exactly as programmed without any possibility of downtime, censorship, fraud or third-party interference." (DeRose, 2013). In simple words, smart contracts, another name for digital contracts, are integrated with an if-this-then-that (IFTTT) code that gives them capability to self-execute. Blockchain technology eliminates the requirement of an intermediary to execute the contract. Digital contracts can be used in a number of business situations as real estate and property law, various types of financial services and crowd funding agreements among others. Company Slock, an Ethereum-enabled IoT platform uses this to enable customers to rent bicycles by unlocking a smart lock subsequent to agreeing to the payment, destination, distance other terms of the contract. Researchers have categorized applications of blockchain technology as financial and non-financial (Crosby, 2016) since digital currencies are a major segment of the existing blockchain networks. Different authors use different versions of blockchain i.e. Blockchain 1.0, 2.0 and 3.0. Blockchains are also classified based on their features and benefits (Briner and Denyer, 2012). This paper has included actual as well as futuristic heterogeneity of blockchain technology solutions.

Research on blockchain: This technology is still in the R & D phase. Very less effort has been taken to utilize blockchain networks across different fields of business. A number of companies are trying to use this system to streamline their operations to attain sustainability and increase futuristic prospects and profitability. While many authors and researchers also criticize the use of blockchains, there is still a need to evaluate all aspects of this system in various research areas.

Aletheia and Eureka, created in 2018 and 2019 respectively are open research platforms. Since the potential use of blockchain are varied and numerous, forming open research platforms, marketplaces or repositories to enable collaborations across different businesses and free access to research data, should support research efforts. Traceability

feature of blockchain is an enabler of trust & transparency and facilitates protection to the contributors.

Project Bloxberg is a blockchain network of research institutions that have formed a private blockchain system to foster, share data, collaborate, peer-review, handle research claims, and publish the research papers in secure global environment. (Vengadasalem, 2019)

Currently, blockchain technology is being used in financial fields for specific business services like settlement of financial assets, market prediction and fiscal dealings. Ripple has created a crypto-currency XRP [by GPSG - Global Payment Steering Group], and operates an open-source system enabling global payments and currency exchanges (Britto, 2012).

Crowd-funding is another application of Blockchain Technology. Target groups for crowd funding operations are the people who are searching for funds and investors. Example of such crowd funding platform is Scientific Coin, which was initiated in 2018.

For any business operation, resource is limited. A blockchain can serve as a ledger as well as a distributor of digital resources and share those resources with the users of the network, like storage space. It also provides security to the data. Examples of such projects are Storj (2018), Filecoin (2017), Swarm (2019), etc

Another area where blockchain technology is rapidly emerging is verification of integrity. Blockchain based applications for verification store data related to production of products or services (Bhowmik and Fenk, 2017). This integrity verification has following characteristics:

- Provenance – Record of creation and ownership of data
- Counterfeit Identification
- Insurance
- Intellectual Property (IP) Management

Blockchain technology can also be used for Governance by creating personalized 'self-management practices' for firms who use self-organising teams and projects with authority and decision-making power. It can also be used in large scale operations where different organizations or entities need to interact regularly, resulting in time and cost saving. The World Citizen Project is a regionalized passport service to identify nationals all over the world. It has enabled creation of digital identity of people.

The rising possibilities of the blockchain and Internet of Things (IoT) technologies are already huge on their own but the symbiotic relationship of these two fields may create a range of new fields. Around 90% of the data in the world present has been created in the past 4 years alone and this growth pace is the result of advent of the Internet of Things (IoT) and population growth. Blockchain technology will enable to orderly store data or future use. (Huh, 2017). IBM has developed ADEPT - Autonomous Decentralized P2P Telemetry system in 2015 that uses blockchain to create a distributed network of devices.

Blockchain Technology can play a revolutionizing role in the Healthcare industry in areas like healthcare management, keeping and sharing patient medical record, drug tracking,

prevention of counterfeit drugs, clinical trials, medical claim settlements, etc. (Mettler, 2016). The possible applications of blockchain in the field of energy are at present impractical and futuristic. But extensive study and implementation of it can lead to costs reduction and enable new business designs and marketplaces, manage complexity, provide data security and ownership, can engage prosumers in the energy market acting as enabler for the creation of energy communities (Bilal, 2014). Also of note is that researches are underway on blockchain as an enabler for de-carbonization of energy market by easing its move towards a more de-centralized energy source. (PwC and World Energy Council, 2018)

These are a few of the areas where the application of Blockchain Technology is being extensively studied and experimented. This paper deals only with the theoretical aspect and systematic literature screening of blockchain technology, especially its use in the Supply Chain Management, as discussed in the succeeding section.

Blockchain Technology in SCM: A supply chain is described as a network linking the nodes with activities associated with them, between an organization and consumers to produce and deliver products and in the process creating value. The supply chain facilitates the movement of goods, services, information, people and resources. There are various elements in the supply chain that cannot be efficiently tracked or even delivered across multiple locations in supply chain. So, management of supply chains is required. (Dickson, 2016)

SCM is the active management of all operations in the supply chain that add value to the product as it moves through the supply chain and thus gain a sustainable competitive advantage over competitors. Partners in the supply chain aim to streamline operations to achieve efficiency and effectiveness. The activities in a supply chain include product development, sourcing, production, and logistics, as well as the information systems needed to coordinate these activities. (R. Handfied, 2020)

Blockchain Technology has huge potential to substantially change traditional SCM. As a result of globalization and increased competition in international market, the supply chains are getting more complex in nature, actively involve the stakeholders of the company and increase in reliance of intermediaries in its operations. All these factors have resulted in increased cost, delays in deliveries, loss of important data, increased risk, etc. To counter the issues associated with the traditional supply chain, blockchain has emerged as a strong contender which can create seamless supply networks.

It becomes imperative to know if the integration of blockchain technology in supply chain is feasible, before discussing the research given by different authors on uses of blockchain in SCM (Kshetri, Kshetri, O'Leary, 2017).

Blockchain technology can be utilized in a number of areas in SCM:

Self audit: The audits for all the transactions and movement of materials in the supply chain can be automatically done, eliminating the cost for verification. It also improves Inventory management.

Provenance and Traceability: It is predicted that Food Supply Chains would be the first to utilise blockchains, especially for fresh products like fruits, vegetables, etc. This is because various diseases are food borne or food acts as vectors of some diseases like Cholera, typhoid, etc. It will also help in tracing the origin of products and the stage at which food got contaminated.

Procurement: Blockchain can become the single source of record for all the purchase transactions. The system has a digital database that contains all the relevant data of all the partners of supply chains, giving a company a 360 degree visual of the supply chain network and blockchains can be used at every stage of the Procure-To-Pay Process.

Logistics: In view of the situation created by Covid-19 pandemic, disrupting global supply chain networks, it is all the more crucial to create a flexible and resilient supply chain that can deliver in times of crisis. Blockchains in logistics can be utilized to identify counterfeit products and enable tracking of origin, facilitate the seller and buyer to transact directly without requirement of a third party. (Subhramanian, 2017)

Digital Payments and Contracts: Digital contracts can be utilized in a number of situations. Two major examples are financial services and real estate and property law. In supply chains, it can be used to form agreements between producers to sellers, sellers to retailers, or directly between manufacturers to consumers. The important feature of these smart contracts is that they are unbreakable. (Hackius, 2017) Payments can also be made virtually on blockchains without the transactional fee.

Scalability: Virtually, a large number of participants; consumers, sellers, manufacturers or distributors can access the same information and transaction details from multiple touch points at any time. (B Muhri, 2018)

Irreversibility & Immutability of Data: The Blockchain system contains a verifiable record of all the single transaction ever made and stores it in a block. This prevents previous blocks from being changed which leads to reduction in double spending, fraud, abuse, and altering of transactions information.

Few Applications of Blockchain technology in Supply Chain Management: Supply chain firms the world over is beginning to recognize the benefits of using blockchains in their supply networks. For example world's largest companies like Microsoft, Alibaba, Maersk and Amazon have invested a large amount of money in this technology. They have conducted their own research which states that Blockchain technology has the potential to increase 15% of sales and 5% of GDP. (Robinson, 2016)

The companies are tailoring the technology to suit their needs and services they deliver. Some start-ups are designing their business model to accommodate blockchain

technology. Some specific examples of blockchain technology in SCM are discussed below:

1. WALMART: Walmart is focusing on using the Blockchain technology for food safety. They aim to enhance the traceability of food products so that the buyers can track the source, raw materials used, the processes the item has undergone and the distribution channel used for (IBM, 2018). Walmart has identified the following benefits of partnering with IBM for food safety in the supply chains:

- Reduction in fraud
- Improved supply chain efficiency
- Increased trust of the customers
- Lower inventory and distribution costs

For instance, Walmart is testing blockchain technology to trace the supply chain of pork from China and mangoes from Mexico. Sensors are used to record temperature during transit via a blockchain based system. This way Walmart can assure their customers of the food quality and condition during transit.

Similar methods are now also being used by companies like Nestle, and Unilever. The technology can also track the contamination of food.

2. Project Provenance: Blockchain technology use in provenance building results in traceability for the materials and products. The Project Provenance Ltd. allowed tracing the origin of raw materials and products through recorded data. Provenance has utilized blockchain tech through smart phones to track the physical location of produce and substantiated its attributes from origin to point of sale. Provenance has utilized a peer-to-peer network for tracking tuna fish that was caught in Maluku (Indonesia) to it reaching a processing plant and beyond. This shows how blockchain tech can be used for supply chain traceability and transparency.

3. Microsoft: Microsoft created an alliance with Adent (a supply chain tracking solution provider) to form a blockchain and artificial intelligence-based service. This service is named Adents NovaTrack. The objective of this service is to develop visibility and traceability in the supply chain, from the origin to the end point. It allows the users to trace a product along the entire supply chain. This solution was originally developed for the pharmaceutical industry to be able to track the distribution of authentic drugs and trace out the illegal and fake drugs in the supply chain. But sensing the appeal of the service, the developers are also modifying the service to target other high-value industries.

4. UNITED PARCEL SERVICE (UPS): UPS is one of the largest logistics service provider in America. The company delivers an average of 5 billion packages, legal papers and letters to nearly 9 million customers across 200 nations and territories daily. UPS is a part of the BiTA (Blockchain in Transport Alliance). BiTA includes worldwide operating firms

like BNSF, GE Transportation, FedEx, and many other international logistics operators. BiTA aims to increase the common standards for the logistics and transportation industry by collaborating best practices and techniques which will ultimately lead to global networking

5. ShipChain: ShipChain, a startup, is aiming to design a comprehensive blockchain-enabled tracking system. This system will be able to track end products from their source (as raw material) to the production facility for conversion into finished products, to the final location of delivery to the buyer. All transactional information including transportation between nodes to the location the product passes through will be recorded in form of blocks in the blockchain tracking system. The system will also be to manage digital contracts that are self-executing when the contractual terms and conditions are met. This means that when a confirmed successful delivery is entered in the system, the system will record the work as completed and assign a fresh duty to the deliverer.

6. ZIM Integrated Shipping Services Ltd: ZIM is an Israeli shipping company presently testing digitalization of the “Bill of Lading”. The Bill of Lading is an essential shipping document in international trade that specifies information such as the destination of goods, their quantity, description and specific handling instructions. ZIM aims to eliminate the inaccuracy in the Bill of lading document. The company in partnership with Wave Ltd and Sparx Logistics, recently conducted successful pilot testing of a digital Bill of Lading. For the pilot test, blockchain system was used for delivering, receiving, and transferring bills of lading. A consignment of goods in containers from China to Canada used a secure regionalized blockchain based network to issue, transfer and manage shipping and trade-related documents. This service is free of cost for all parties using the application for international trade. The trail run recorded a successful delivery of containers to the destination. The use of blockchain based digital bill of lading provided correct information and faster transfer of original documents. This value-added operation makes the supply chains more efficient and cost effective.

Analysis:

Blockchain Technology is an insurer of transparency and security of information in supply chains. This technology also provides effective solutions to counter the challenges of traditional supply chains. Registering the activities and transactions in the blockchain system can help in reducing the costs, risks and losses associated with supply chain network.

Table 1: Summary of improvised SCM elements with BCT features and application benefits

Sl. No.	SCM Elements	Features of BCT	Benefits of BCT in SCM
1	Procurement	Provenance	Accurate Inventory Management

2	Product Marking	Secure	Right Product Packaging & Labeling, Counterfeit Identification
3	Distribution Strategy Development	Decentralized & Consensual	Can form Complex but Efficient Supply Chains, cost effective
4	Carrier Selection	Traceable	Minimizes the risks & losses with product movement
5	Logistics	P2P Network	Strategic Partnership with SC workers
6	Freight Distribution	Scalable	Caters to wide range of consumers
7	Route & Network Optimization	Traceable & Automated	Reduces delivery time & Selects right route for transportation
8	Bill Payment & Audit	Privacy & Transparency	Keeps Financial & Personal details private & secure but accessible to right parties
9	Product Returns	Traceable	Easy Backward Integration of SC
10	Information System	Data Immutability	Data Verification at each stage, reduces Human Errors

Relevance of Blockchain Technology in Supply Chain Management: This paper has carefully examined the various literature present on Blockchain Technology to try and meet the objectives of the thesis. Systematically reviewing the work and comparatively analyzing it with each other, gave a comprehensive insight on the relevance of Blockchain Technology in business and specifically in SCM.

Blockchain technology impacts supply chain activities along with financial transactions and management of goods among the supply chain partners. A significant advantage of blockchain is that it eliminates the necessity of intermediaries in processes like money transfer services and payment networks.

The blockchain system brings efficiency in the trading processes among supply chain partners. Traditional supply chains are impacted by inefficient reverse information, money flow and lack of transparency with negligible accountability leading to dissatisfaction.

Blockchain technology becomes a driving factor in organizing logistics and supply chains to cater the stakeholders' demands and provide increased productivity by concentrating on core activities and operations. Smart contracts, an important application of blockchain, are proficient in organizing financial procedures ensuring adequate funds are available and employees are paid on time. They provide a basis for transaction between two or more currencies in global supply chain in a secure way.

The future scope of Blockchain Technology is vast. This technology provides great opportunities to create new, specialized and customizable networks in different areas of business. This will result in innovation across industries which are suited for the dynamic environment.

Discussion: The diversity of blockchain technology applications in business can create sustenance for meeting the future requirements of business. Blockchain Technology provides four specific aspects that improve coordination and enable integration of the users of a Supply Chain:

1. Transparency - Transparency refers to the shared record of information which is stored in the blockchain from various sources and users of supply chain network.
2. Validation - Immutability of data and consensus-based verification enable validation of information in the peer-to-peer network.
3. Automation - is the capability to execute digital contracts and other agreements based on validated information in the blockchain. It gives permission to execute operations in supply chain if pre-established conditions are met.
4. Tokenization - Blockchain allows creation and distribution of tokens that represent a particular claim on any valuable asset and its exchange between blockchain participants.

THE APPLICATIONS & ASPECTS OF BLOCKCHAIN TECHNOLOGY

Following are the major applications of Blockchain Technology divided into 6 categories based on two aspects -

1. Record Keeping: The storage of data in blocks
2. Transaction: Verification of the transaction information

Table 2 : Summary of Blockchain Aspects & Applications with examples

Record Keeping			Transaction		
Ledger	Identity	Smart Contracts	Decentralized Register	Payments & Audit	Others
Database for keeping records that cannot be changed	Records the personal details and identity sensitive data	Set of Pre-Established conditions for self-execution of operations	Decentralized database that can update information	Allows Digital payments among users of the network	Operations with some variations or customized functions
Examples	Examples	Examples	Examples	Examples	Examples
IP rights, Food Safety, Asset Claims	Identity fraud detection, Voting	Insurance claim, Cash-equity trade, Copyrights	Drug supply chain, IPOs	P2P payments, Payment of EMI	Blockchain as service

NEW STANDARD FOR LOGISTICS – EXAMPLE: Companies like BNSF, GE Transportation, FedEx, and few other international logistics agencies are part of an alliance named BiTA [Blockchain in Transport Alliance]. BiTA aims to increase the common standards for the

logistics and transportation industry by collaborating best practices and techniques which will ultimately lead to global networking.

Benefits of integrating blockchain technology and supply chains:

Visibility of material origin and movement: Big companies have intricate supply chain structures making record keeping a humongous task. Lack of transparency is another factor. Blockchain-based supply chains simplify record keeping and makes tracking of sources visible to all users.

Cost reduction: product and information tracking in real-time in throughout the supply chain enabled by blockchain technology reduces the cost of material movement.

Developing trust among participants in the supply chain: Trust among the multiple stakeholders in the supply chain is a pre-condition for streamlining operations. Each partner should be able to trust that those involved with production are adhering to quality and safety standards in their factories.

Highlights of Blockchain Technology in SCM:

- Concentrate to improve core activities and operations
- Increase customer satisfaction through enhanced service delivery
- Integrate the entire supply chain for better coordination
- Reduce conflicts among supply chain partners and help to attain mutual goals
- Increase efficiency, stability and flexibility
- Increase productivity which will lead to increased profitability
- Reduce risk, uncertainty and fluctuation of the business environment
- Optimum utilization of resources. No resources should be under or over utilized.
- Improves access to data, expertise & knowledge of market
- Provides competitive edge in global and local market
- Decreases cost of equipment and employees

Criticism of Blockchain technology: There are a few shortcomings in application of Blockchain Technology in SCM. They provide insights on why despite the benefits, blockchain enabled supply chains are still in R&D phase and not yet implemented across industries. Following are some of the disadvantages:

- Slower Processes: Blockchain system can slow down if there are too many users on the network.

- High Energy Consumption: The running of the technology can sometimes consume too much power to operate certain functions.

- Inefficient: with current knowledge and infrastructure, using block chains can cause trouble in supply chains.

- High Cost: The cost of shift from traditional to blockchain based supply chain will be substantial.

- Interoperability: Large number of organizations presently uses conventional method. So, different organizations cannot transact or operate with each other using this technology.
- Harder to Scale: Due to consensus method of data validation, changes cannot be made and cannot give visibility to all the uses.
- Self Maintenance: Users of the system have to maintain their own wallet and else lose access.
- Integrations: Blockchain technology needs integration, not only in supply chains and other business areas but also in various institutions like legal, government, etc. to become fully matured and operational.

Conclusion:

Blockchain technology used in crypto-currency and Bitcoins has certain key features that enable it to solve present and future problems, not only in financial area but also in other areas of business. The technology is not yet developed and integrated in general operations of supply chain management to its full potential. This is because of financial constraints and the lack in accepting the technology at various operating levels of supply chain.

Application of blockchain technology in supply chains can transform the traditional supply chain network by countering the challenges and issues a traditional supply chain has. This technology would help by streamlining the activities of supply chains like procurement, manufacturing, loading, distribution, carrier selection, freight details, route management, packaging, delivery, etc and make it more transparent, cost effective, efficient and immutable. It will also mitigate the risk associated by making the supply chains traceable and responsive to the changing dynamics of the environment.

Food, raw materials and all present industrial products are transported long distances and require cheap, smooth supply network that is enabled by automation and digital tracking. Blockchain technology significantly reduces time delays, costs and human error associated with the supply chains. In addition to this, it provides better scalability and security, and enhances the networks transparency. The technology simplifies a large and complex supply network, addressing the concerns of the global supply chain and consumers.

Limitations of the research:

This paper has comprehensively and critically examined the current literature present on Blockchain technology to complete the objective stated. However, the study has potential limitations in that it is based on secondary data from various sources which is amenable to ambiguous interpretations. The topic majorly defines “Blockchain Technology”, which is still in its Research & Development phase, and is presently in limited execution across different business sectors. So, this paper does not give concrete evidence in support of the result.

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