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Blockchain-Driven Logistics Using Ethereum: A Review

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Abstract—Everyday life depends heavily on the supply chain, and its traceability guarantees the quality and safety of the products. Thus, there is a pressing need for an effective and trustworthy solution to enhance logistic traceability. Traditional traceability systems suffer from low tracking efficiency and inconsistent data. However, the developing blockchain technology promises to improve these issues by being transparent, tamper-proof, and decentralised. This article analyses previous research, highlights problems, and investigates logistic traceability options based on blockchain. First, the conventional traceability approach and stakeholder demands are explained, along with the fundamentals of blockchain technology. Next, a thorough evaluation and analysis of the current publications and enterprise applications is conducted. Lastly, difficulties and potential lines of inquiry are explored. Subsequent studies may concentrate on developing focused consensus processes, creating suitable access controls, examining the function of regulators in the supply chain, etc. This analysis demonstrates that although there are still many obstacles to overcome, blockchain offers a lot of promise to solve traceability problems.
Keywords-Blockchain, security, logistic management, traceability, transparency.

I. INTRODUCTION

Goods, including those sold in stores, online, and in other locations, giving them the flexibility to choose which logistic priority to concentrate on. When discussing the primary challenges within contemporary logistic management (LM), it becomes evident that,

1. The logistics system is centralized nowadays. However, a centralized logistics system lacks essential capabilities for market analysis and can be costly and time-consuming to run.
2. The enormous expenditures that logistic participants are compelled to endure, owing to the complexity of value networks and supply chains, ultimately fall on customers. The bulk of the data used in the articles is stored on BC, which can be an expensive endeavor.
3. The existing configuration of the logistic lacks the requisite traceability and transparency.
4. In today's logistic landscape, customers and stakeholders deal with challenges such Order management, inventory control, and expiration date tracking coordination, inventory control, and reliance on human resources. As a result, stakeholders are unable to assess demand, which makes it impossible to maximize output and storage.

The foundation of conventional logistic management is a centralized methodology. The procurement, distribution, and logistics department managers are located at one corporate office and one warehouse. These managers are in charge of their particular location's activities across the whole supply chain. They monitor the data in a localized database that is centralized. If the information does not aid in the expansion of the business, it can be a little off. Consequently, a growing mistrust exists amongst firms, driving up the cost of communication. Because of the middlemen, there is also a lack of pricing transparency in the supply chain. Furthermore,

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data cannot be compatible with logistic organizations due to the increased possibility of data tampering inside the organization.

The modern logistic does not encrypt the private information of customers. This data will be vulnerable to cyberattacks, which might disclose both public and private information. Commodities only flow one way, which is a major problem for modern logistic management. Consequently, in the event that a product is defective, the client has complete responsibility. He was limited to using the circumstances to his advantage. Facilitating the reverse movement of products and transactions for each customer is a significant difficulty in traditional logistics system management. Attacks on the Logistic Care a serious problem in modern SCM. Logistic attacks go at suppliers and vendors rather than a single business. This attack goes against a trustworthy third-party vendor.

The need for SC's effectiveness, safety, and justice has increased dramatically in the modern day. Stakeholders are starting to ask for an SCM approach that is more transparent. End consumers are interested in knowing every detail regarding the things' provenance. It is necessary to develop a tamper-resistant tracking technique to solve such an issue. Decentralizing infrastructure and establishing a trust layer for business logic might both be drastically altered by BC technology. By gradually covering encrypted data, BC—a permanent, unchangeable record system was produced. The primary components of the BC system are decentralization, Tracking, tamper resistance, and cryptographic protection. Furthermore, safe transactions between often untrusted parties are made feasible by smart contract technology.

A smart contract is one type of digital agreement or contract. A smart contract can be configured to carry out a certain action without the help of a third party after a predetermined goal has been accomplished. Furthermore, BC can help with stakeholder confidence and quality control.

A. Comparisons with the Existing Surveys

Supply chains and other non-financial businesses are some of the applications of BC that are most commonly studied. Using BC technology is the most effective approach to solving logistic issues. Exploration of blockchain technology's potential application in logistic management has led to the production of several publications that provide an overview of the field's present status as well as a roadmap for future study. These components have motivated us to investigate different supply networks in the proposed survey.

This section compares and contrasts recent works that address the integration of the BC and SCM. A comparison between the planned survey with the current surveys is shown in Table 2. It also emphasizes their main goal, notable successes, and shortcomings. This might provide helpful information to beginners.

B. Motivations and Contributions

i. Motivations

The growth of several sectors has led to the acknowledgment of logistic system management as a management strategy. Supply networks are by their by nature complex, including several partners and economic operations. For a variety of reasons, including traceability and transparency, the rise of fake goods like phoney medications, the challenge of handling risks and disruptions while establishing trust and credibility traditional logistic networks are at odds with COVID-19. The need for a traceable, secure, and transparent platform has been met by utilizing BC technology. The majority of logistic networks in use today include tracking and traceability technologies, these present challenges with centralized governance and safeguarding data. Academics and industry have shown a great deal of interest in British Columbia, The supply chain's present systems will be altered, and third-party systems will lose control due to BC's cutting-edge technology. It is able to overcome certain logistic obstacles. The capability of technology to transparently and securely track various transactions prompts us to explore the potential benefits blockchain offers throughout the supply chain.

Table 1 Recent breaches in the supply chain

Company Name	Year	Description
Mimecast [139]	2021	In order to use Mimecast's email security services and access Microsoft 365 accounts, users must establish a secure connection with Mimecast servers. The hackers obtained login credentials, granting them access to the provider's network and certificates. After the consumer validates and trusts the certificate, they exploit it to access customer data.
SITA [140]	2021	SITA specializes in information technology for the aviation and transportation sectors. Attackers breached SITA servers and accessed passenger data belonging to SITA's clients.

Kaseya [141]	2021	Kaseya, a software service provider, specializes in remote administration and monitoring technology. Exploiting a software vulnerability, attackers infiltrated Kaseya's systems and deployed ransomware on clients' infrastructure through this access.
APPLE XCODE [142]	2021	A programming environment called Apple Xcode is used to create OS X and iOS apps. A backdoor was exploited to infect Xcode developers with a solitary malicious Xcode project.
CLICKSTUDIOS [143]	2021	Solutions for managing company passwords are offered by ClickStudios. Password state, a password management tool, is their primary offering. Users were tricked into downloading malware instead of the planned application updates using Password state's hacked "upgrade director" online interface. The malware that was released was designed to pilfer data from the compromised systems. [143].
BIGNOX [144]	2021	One supplier of emulation software is BigNox. NoxPlayer, their main product, is a widely recognized Android emulator available for Mac and Windows platforms. There has been cyberattack on NoxPIayer's infrastructure. It could utilize the tool's update mechanism to disseminate malware instead of legitimate updates.
VERKADA [145]	2021	Verkada provides cloud-based security surveillance solutions to more than 5,000 clients. Cybercriminals gained access to the production server. As a result, attackers with privileged credentials might now access security cameras placed on clients' property.
SOLARWINDS [146]	2020	Software for administration and monitoring is offered by SolarWinds. Orion is the name of the network management system (NMS) from SolarWinds. Something had endangered Orion. Once the attackers gained access to the SolarWmds network, they used it to gather and illicitly acquire data.
ABLE [147]	2020	Able is a Mongolian enterprise providing software solutions to local businesses and government agencies. Attackers embedded the virus within the "Able Desktop" application, which was subsequently employed to pilfer data from compromised devices belonging to customers.
Ledger [148]	2020	One business that makes hardware wallets is called Ledger. To find legitimate login credentials for Ledger records and client data theft, The attackers leveraged open-source intelligence tools and exploited consumers' trust in Ledger by sending phishing emails.

However, implementing cutting-edge technology in any industry may come with challenges. The logistic business is still relatively new to BC technology, thus its full potential has not yet been realized. Small and medium-sized businesses (SMEs) would be impacted by BC technology in both a social and economic sense. Hence, assessing the scalability of blockchain solutions is crucial.

ii. Contributions

This article examines the current state of BC technology implementation in many logistic network businesses. We have carried out a thorough investigation of the application of BC in food and health logistic networks. This work greatly improves the field by providing new insights into the theory guiding the supply chain's adoption of BC.

The research contributions of this publication are as follows:

- to examine the potential advantages of utilizing BC to improve a range of tasks in diverse logistic networks.
- to list some potential applications for BC throughout the logistic system. to investigate and talk about the many concerns surrounding the current and future use of BC technology in logistic networks.

The writer's input on the survey's execution is a superb understanding of how BC technology was adopted and implemented during COVID-19 in the current logistic networks.

C. Methods and Materials

To give a comprehensive analysis of the acceptance of BC in the SCM, a systematic analysis and study were conducted as an element of the research methodology for the suggested survey. We began by reading review papers on supply chains in British Columbia from respectable conferences and databases, such as Springer, ScienceDirect, ACM, Taylor & Francis, Wiley, IEEE Xplore, and Google Scholar. Subsequently, we explored several system

applications developed on blockchain (BC) technology. The objective of this investigation is to scrutinize the potential benefits of augmenting current logistic networks with blockchain technology. When conducting this search, consider utilizing keywords such as BC Technology, Logistic Management (SCM), BC Use in SCM, Provenance, and Logistic Traceability. Lastly, we reviewed the

A. Research Questions

The final purpose of a research paper is mirrored in its research questions, which are also very important when choosing primary sources. The goal of this project is to get a deeper understanding of, assess, and investigate the potential of BC technology to offer affordable solutions to issues with existing logistic systems.

We examined BC's potential in safe logistic management due to many study concerns. These are listed in the following order:

RQ1: What benefits come with putting in place logistic management systems located in British Columbia?

RQ2: Has BC lately found any use in the logistic industry?

RQ3: What main concerns have supply chains encountered since BC's implementation?

RQ4: Will there likely be a future growth in the usage of BC in SCM?

Table 2: Comparison between the suggested survey and the current surveys.

Related Survey	Year	Objective	Key Contributions	Restrictions and Unresolved Questions
[135]	2022	In order to address the current challenges facing the logistic ecosystem, The purpose of this study is to look at the variables that affect logistic management's adoption of blockchain technology.	Blockchain technology, intercompany cooperation, technology, extrinsic factors, and innovation frameworks are all carefully considered in order to apply it to supply chains.	This research did not use any qualitative approaches, including focused group talks with industry experts.
[136]	2022	The aim of this research is to investigate and evaluate the potential applications of blockchain technology in the management of the agrifood logistic(AFSM).	In the agrifood industry, this study underscores the significance of food safety, traceability, transparency, the elimination of middlemen, and the integration of blockchain technology with the Internet of Things (IoT).	This research is limited to the logistic for agrifood. The suggested honey traceability system based on blockchain has not yet been put into practise.
[1]	2021	Stakeholders from a range of pharmaceutical companies and drug regulatory agencies in Nigeria were interviewed as part of this study to ascertain the viability of integrating blockchain (BC) technology into the country's pharmaceutical logistician order to lower the prevalence of counterfeit medications.	The potential integration of BC technology into Nigeria's pharmaceutical logistic is being investigated as a means of reducing the availability of counterfeit pharmaceuticals.	This study is restricted to the pharmaceutical logistics system in Nigeria.
[2]	2021	Examine the many BC-based strategies that can aid in the prevention of medication counterfeiting.	Look at a few BC-based strategies to stop the fake medication trade.	The procedure is not really being executed.

[3]	2021	This essay seeks to understand how implementing BCT in SCM could affect trust. The basis of BCT trust is made up of the sub-dimensions of provision, certification, delegation, infrastructure (for the platform), and authenticity and dependability (for the records).	The purpose of this research is to investigate how confidence may be affected by using BCT in SCM.	Additional advantages of BC technology for the logistic system, such reliability and security, were overlooked.
[4]	2021	an examination of the several BC-based solutions that have been suggested for use in different SCM domains.	An extensive analysis of fifteen research papers was carried out to provide a deeper understanding of the functioning of BC and its potential uses in logistic settings.	For the applications that were considered, they didn't do a thorough evaluation of the literature that was accessible.
[5]	2021	Perform statistical analysis according to the article's categorization in the year of publication, prestigious research institutes, and research order to display a multidimensional trend.	According to the survey's authors, BC has the ability to promote data interchange, improve corporate operations, reduce operating expenses, and increase the effectiveness of teamwork.	The author offers no suggestions for real-world use.
[6]	2020	To give a general picture of the supply chain's use of smart contracts and blockchain technology, 106 review articles were analysed.	Four main concerns were found in this: logistic integration, digitization, cooperation and engagement from stakeholders, and traceability and transparency.	The process has not yet been implemented.
[7]	2020	Use ten different logistics applications as a case study to build an explanatory model that explains how participants in an operational logistic interact with BC technology.	This study sheds light on the concept of a business model and how logistic management and operations will change as a result of BC technology and (dis-)intermediation.	They haven't worked in a complicated global logistics sector with lots of diverse companies.
[8]	2020	Based on the projects' dates of creation, BC types, status, industries they were applied to, and types of companies involved, 271 BC initiatives were assessed.	This study looks at the state of BC's logistic efforts.	They didn't carry out a thorough examination of different initiatives, including financial information.
[9]	2020	To evaluate BC's applicability and present uses in the logistic industry, the survey's authors examine the advantages and drawbacks of dispersed logistic organisation and management.	The foundation laid out in this study will allow scholars and practitioners to concentrate their future research efforts on improving BC technology and its logistic applications.	There is still no implementation in intricate supply networks.

[10]	2020	The goal of this study is to demonstrate how BC technology is applied in the dairy sector. Its main objective is to enhance the dairy logistic system by utilising BC technology.	The possible applications of BC technology in the dairy logistic system are examined in this study. and the advantages that might accrue to different parties involved as well as the dairy industry overall.	The author offers no suggestions for real-world use.
[11]	2020	The several organisational ideas applied in BC literature on logistics and transportation are identified in this research (ISCM).	The resource-based perspective, agency theory, information theory, institutional theory, network theory, and transaction cost analysis are the six organisational theories that guide the structuring of BC literature.	The study included no mention of or commentary on pertinent instruments and methods that might help clarify how LSCM and organisational theories relate to one another.
The Proposed Survey	2022	Examine BC's uses in safe logistic management.	This study integrates the functionalities and technological underpinnings of BC technology to thoroughly investigate the current state of academic research and application scenarios.	

B. Data Sources

We looked through popular, peer-reviewed journal databases including Elsevier, ScienceDirect, IEEE Xplore, and Springer to find the most recent online resources and literature reviews. In addition, we drew upon other resources, including technical books on the topic, concessions, envisioned webpages and digital content relevant to the present investigation.

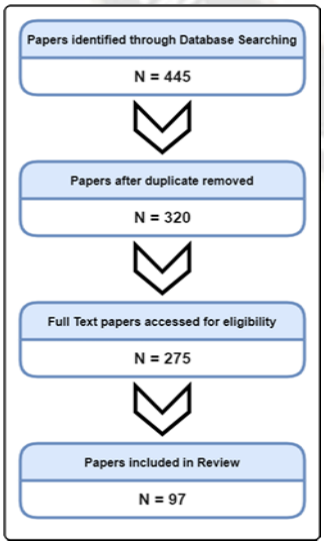

Figure 1: Survey criteria [N = No. of Papers].

C. Search String

Specific terms and their equivalents from the planned study subjects are chosen to generate the search string. Then, by placing the keywords in a certain order and using the criteria "AND" and "OR," the following query is generated:*((''Blockchain'' OR ''Blockchain Technology'' OR ''Dis- tributed Ledger'' OR ''Decentralized Ledger'') AND (''adoption in'' OR ''acceptance in'' OR ''use in'') AND (''Logistic Management'' OR ''SCM'' OR ''Secure Supply chain'')).*

D. Inclusion Criteria

The inclusion criteria are as follows:

i. publications published in the first half of 2022–2016.
ii. articles presented at conferences, in peer-reviewed journals, as book chapters, or in conference proceedings.
iii. Papers on safe logistic management are being written.
iv. The focus of the articles is logistic system management leveraging blockchain technology. The most recent papers are prioritized.

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II. SCM AND BLOCKCHAIN TECHNOLOGY: BACKGROUND, DEFINITION, AND MOTIVATION:

In this section, let's begin by discussing logistic management. Following that, we'll delve into the fundamentals of Blockchain (BC) Technology, including its operation. Finally, we'll explore the application of blockchain in logistic systems in the third section.

A. Logistic Management

The main goal of logistic management, or SCM, is to transfer goods and services between locations via a range of stakeholders. The objectives of supply chains, which are made up of several individuals, objects, activities, and organizations, are to fulfil customer demands and transform raw resources into finished goods. The seller creates and delivers a good or service to the customer through a prearranged information flow, physical delivery, and payment. It is a network of people, organizations, events, data, and resources that are interrelated. The transaction ends when the customer receives the finished commodity or service.

A manufacturer receives raw materials at the beginning of the process. management of the goods and services logistic to ensure. There is minute information on how the product is made, handled, and delivered to the final consumer. Large corporations oftentimes only made part of their data available to the public. Many characteristics of a product may be challenging to validate if there is insufficient product expertise. Customers could find it challenging to confirm the existence of some product components that the manufacturer states are there. Consequently, there is an increasing lack of confidence in all endeavors, which raises the cost of communication.

Additionally, information in supply chains is unpredictable due to the high risk of data manipulation for the organization, which makes it simple for the process of product traceability to be disrupted. In an ordinary supply chain, Additional problems including fraud, tampering, missing or delayed shipments, delayed delivery, and counterfeit goods might arise. Traditional supply chains have therefore been unable to meet the demand from consumers for cheaply cost, high-quality items. [20].

Efficient logistic management's main objective and difficulty is to optimize the supply chain's presentation with external repercussions like client attention and internal efficiency (SCM). Waste, problems, and obstacles must be found and removed in order to do this. Throughout the whole internal supply chain. Logistic module integration requires blockchain dedication, trust, collaboration in decision-making, and accurate information sharing.

B. Blockchain

An example of a database or storage system that connects blocks to store data is called a blockchain. Fresh data is appended to a fresh block and linked to the prior Blockchain as it becomes available. A data chain known as a "Blockchain" is created when separate blocks with different storage capacities are connected to the prior full block as they reach their maximum capacity. The exploration of the blockchain concept began in 1991 with Stuart Haber and W. Scott Stornetta. Their objective was to establish a system that prevented the alteration of document timestamps. Subsequently, a peer-to-peer network named Blockchain was created by an anonymous group under the pseudonym Satoshi Nakamoto. in 2008, double-spending was eliminated. A year later, Bitcoin emerged as a digital money.

A blockchain, often referred to as a branch chain, is a distributed ledger that uses encryption to build an immutable chain of data. Each record is approved using a specific consensus process, and it is kept up to date by a decentralized network. Since BC is a distributed ledger, network management and control may be carried out without the need for a central authority or administrator. To put it briefly, BC is made up of a collection of blocks that are publicly accessible and contain chronologically recorded transactions that are neither tempered nor backdated. The decentralized nodes employ a consensus algorithm (user systems) to validate the transactions. Rather of being controlled by one entity, the ledgers are shared by all players. Data is very difficult to modify once it is saved on a BC. A database known as a BC only permits users to view and add data [104].

i. Types of Blockchain Networks

There are several methods for creating a BC network. They can be created by an organization or, with permission, by the general public (consortium). Networks Accessible to the Public in BC: Similar to Bitcoin, anybody may join and take part in a public BC.

This kind of BC requires a lot of processing power for transactions, and the security and privacy are either nonexistent or very limited.

- *Private BC Networks:* A single business oversees a private blockchain network for its clients, selecting users, completing a consensus procedure, and keeping an eye on the shared ledger—that is, the organization's private blockchain network. This might include using a BC inside. Interestingly, On public BC networks, permissions can also be changed. All users have access to the public, permissioned BC network, where blocks are validated by pre-selected nodes. The block's validity

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in a private Permissioned BC is fully centralized and managed by an organization. A private or permissioned BC therefore regulates who may join the network and what kind of transactions they can do. An invitation or authorization is required before participants may start the activity.

- *Consortium BC:* Companies that work together could still have a BC. Pre-selected firms manage transactions and data access in this kind of BC. When all parties share accountability for the BC and need permissions, a consortium BC is acceptable. A comparison of two well-known blockchain networks is shown in Table 3.

III. ADOPTION OF BLOCKCHAIN IN SUPPLY CHAIN: A SOLUTION TAXONOMY:

Here, We offer a taxonomy of solutions for integrating BC into the SCM. Among the BC uses is the supply chain. that gets the most attention. The complexities of the interactions amongst stakeholders, the necessity of parties exchanging information, the danger and challenge of document transmission, and the lack of confidence across supply chains, parties, and BC implementation make it very promising [17].

BC uses transaction security, traceability and authenticity in a setting where there is mistrust. Using BC in supply chains offers a number of advantages, including as less paperwork, improved productivity due to quicker reaction times, higher logistic visibility, processing data in real time while keeping an eye on and controlling it in a virtual environment and fewer regional restrictions [17]. It has been proposed that the application of BC might strengthen product traceability, promote transparency, and increase logistic resilience [22], [68]. With BC, The average time for the system to finish was reduced., order traceability was verified, visibility to several logistic actors was improved, and the burden was reduced overall.

As a result, SCM might be improved in many ways. In BC technology, every stage of the product chain—from manufacturing to sale—is represented by a block, which is then connected to finish the process [24]. Product safety is maintained by ensuring traceability, which prevents information from being altered after the blocks are generated [25], [26], [27]. [28] expands on the list of evident benefits to include immutability and great accessibility. Moreover, BC permits precise monitoring of the quality of the goods during shipment. For example, information about the item's transmission path and duration may be used by a logistic participant to determine if an item was misplaced or remained in one spot for an extended period of time. Since frozen foods cannot be stored at normal temperature, this is very important.

Table 3: Comparison between Ethereum and Hyperledger Fabric Blockchains.

Characteristics	Ethereum	HYPERLEDGER FABRIC
Governance	Ethereum developers	Linux Foundation
Ledger Type	Public/ Private	Authorized
Platform	General-purpose blockchain platform	Scalable blockchain platform
Transactions per second	Fifteen to twenty transactions per second (TPS)	Roughly 3,500 transactions per second (TPS)
Consensus Algorithm	Nakamoto-inspired Proof of Work (PoW) and Proof of Stake (PoS)	Interchangeable Practical Byzantine Fault Tolerance (PBFT) / diverse
BC Forks	Yes	No
State	Account-centric model	Key-value storage system
Confidentiality	Negative (Transparent)	yes
Vulnerability of attacks	51%	more than one-third faulty nodes
Tamper proof	Challenging	Simple
Data Storage	Swarm	CouchDB, LevelDB
Currency/ Token	Ether	FabToken System
Smart contract Type	ETH smart contracts	Chain-code in fabric
Smart contract language	Solidity,Serpent, I I I	Python,Golang,Java
Tokenization support	Yes	No
Key management	No	Yes (through CA)
Scalability	Difficult	Easy

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Suited for	B2C DApps	B2B DApps

Table 4: Principal attributes of BC and their possible roles in SCM.

Characteristics of BC	Description	Contributions to SCM
Immutability	Another name for it is irreversibility. Once the data in BC has been authorised by the nodes, it is almost impossible to change or remove it.	There will be less chance of forged documents, and auditability is improved. Security against deceptive and unfair practises is offered by immutability. [28–29, 33–64, 63–75]
Security	BC ensures security through the use of encryption protocols and cryptographic techniques.	preserving very reliable and secure trade transaction data as well as additional product-related data. 21–32, 69–99, 69–99]
Trust	With the use of complex mathematics, BC establishes a trust less network.	Trade can occur between business partners even if they don't know one another. [17], [34], and [40]
Decentralized	Decentralization implies that all nodes are equal and that no central organisation is required.	It does away with the need for third parties to verify transactions and associated fees. [35, 106]
Transparency and Visibility	All nodes get the data simultaneously when it has been verified. Records and transactions cannot be concealed, fostering more confidence and enhancing the value of the corporate system.	Collaboration between firms and individuals is facilitated by BC, which also makes organisational data and processes more visible. [44]
Tamper-resistance	Any transaction data kept is impervious to manipulation both during and after block construction, a feature known as vandal.	The chain of supplies contributes to reliability and faithby providing tamper resistance. [35, 57]
Disintermediation	A decrease in middlemen between producers and customers is known as disintermediation.	Disintermediation results in a continuous flow of transactions, boosting efficiency and confidence among process participants. [35]

How BC may alter governance choices and transaction costs in the supply chain. Researchers discovered that BC technology may significantly reduce logistic transaction and governance costs, especially when it comes to search and information prices. For a variety of reasons, Kshetri et al. [30] employed BC case studies to determine how they affect the main SCM goals at various stages of development. The study indicates that BC affects value, cost, reliability, sustainability, flexibility, speed, and risk mitigation.

In order to get a competitive edge, [31] asserts that the network's capacity to send operational data in real time can be enhanced and digital solutions can be developed using BC. Another important benefit, Hard-coded rules in a shared, permanent ledger may lessen or do away with the need that company procedures and internal systems carry out audits without the involvement of a third party, making security a crucial aspect of BC technology [32]. Users can choose to reveal their identify or stay anonymous. Users can choose to reveal their identify or stay anonymous. As a result, BC guarantees secure data flow while fostering confidence. Information on a BC increases trust and reduces fraud as it is available to all parties and cannot be altered by just one person.

BC could be able to improve the supply chain's flexibility. Being able to adapt to shifting market conditions and provide products and services on schedule while staying under budget, a logistic has to be flexible. Using BC, it is possible to make sustainability metrics more significant and quantifiable. BC can put a halt to immoral and unlawful behaviors in this way. Logistic and logistics companies may be able to resolve a number of problems by utilizing BC technology, includes liability for items damaged in transit, currency risk, cargo insurance, and more. When it comes to immunization distribution, BC-based systems can completely automate data accountability and supply monitoring [33].

A. Advantages of Implementing BC-based Logistic Systems (RQ1)

Because every stakeholder system's ledger incorporates all the information, the BC platform for the logistic lessens the uncertainty that arises with traditional logistic systems' separate databases [19]. Apart from offering tracking and tracing services, BC lessens the requirement for logistic double-checking. according the interviews conducted by [34]. This is because of automated data validation. By supplying transaction provenance documentation, BC permits transaction monitoring. End-to-end logistic activities are accelerated by BC, which also allows for increased volume and accuracy of data. Applications with BC support spread data over the whole network in a matter of seconds. Consensus approaches provide logistic automation and operational advantages by supplying data veracity and simple foundations for smart contracts. In light of this, BC could improve data

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security, traceability, efficiency, and logistics management transparency [21]. [134] claims that over the next ten years, the world GDP may increase by US $962 billion if provenance is established using BC. The potential benefits of adopting BC in the SCM are depicted in Figure 6. Including BC in the logistic system offers a number of benefits, including:

•The supply chain's coordination and integration need to be strengthened.

•promotes the sharing of information on product maintenance, assembly, manufacturing, and distribution across all parties involved in the supply chain.

•by enabling customers to track the whereabouts of an order or shipment within a certain time frame. The logistic may be more open and reliable using BC.

•Constant observation is more accurate and transparent (Facilitating origin tracking).

B. Applications of BC-based Logistic Systems (RQ2)

BC technology is now used in almost all supply chain-related industries. Two of the most well-known logistic uses of BC, such as the food and pharmaceutical supply chains, are covered in this essay.

I. Food Supply Chain

The World Health Organization claims that (WHO), one in ten people become unwell as a result of eating contaminated food. Those involved in the food logistic include growers, producers, government agencies that certify products, logistics firms, distributors, retailers, and end users. Each of these people shares crucial details about the culinary item while seated at their own private server. Food fraud is more common since other participants do not have access to this knowledge. A consumer relies entirely on the statements made on the label when making a purchase. For the manufacturer of the product, the source of It is vital to have raw materials and processors. The processor accepts the claim made by the farmer, farmer organization, or organic accreditation. Customers plus additional players that provide false or modified information are deceived. By establishing a secure environment, BC makes data that, for all players in the logistic network, once recorded and verified, cannot be altered or deleted. Therefore, it may provide customers with more visibility and monitoring in addition to cutting out intermediaries, saving money, speeding up reporting, and increasing speed. The use of BC technology to address issues with In the food supply chain, traceability and transparency have become more and more popular in recent years. Additionally, BC will use IoT-capable data devices collection and tenacity in order to enhance information security and help with agri-food items' long-term traceability management. When paired with the most recent data capturing technologies, the food industry presents BC with a lot of promise.

Wahyuni et al. [122] examined a seafood industry case study (fish) industry and found risks in the source to provide food SCs. Over the course of the food supply chain's activities, all stakeholders are responsible for preventing chemical and biological contamination. The utilization of ICT technologies is promoted to enhance control and monitoring across all "source-make-deliver" processes, ensuring the protection of perishable foods and minimizing quality variations that pose risks to food safety standards. Feng et al. [40] developed an agri-food logistic traceability system based on RFID and blockchain (BC) technologies. The findings suggest that RFID technology can be employed in the logistics sector for data collection necessary for tracing and tracking purposes. This approach ensures the quality and safety of agri-food products by facilitating reliable data exchange and enhancing traceability measures.

Pincheira et al[123] .'s implementation of BCT Agri BlockIoT using Ethereum and Hyperledger was shown. Within the BCT ecosystem, sensors make sure that smart contracts are carried out, and (IoT)-connected devices gather and send data. Without involving humans, An IoT-based security monitoring and reporting system is developed by the authors of [124]. to update the state of perishables and the SCM with an emphasis on transportation. In order to improve customer confidence, Malik et al. [125] created A group granted BC authorization architecture that removes the highest power node. There are four different types of nodes in this system: validators, governing board, participants, and non-participants. Only customers and non-participating members are able to look into the BC. The parties involved in the food logistic who comprise the participating members are the source of the transactions. The governance board, which is composed of several government agencies, is responsible for deciding what access limitations apply to the contributing members. The network's scalability is improved by the adoption of the sharding technique. Sharding divides data into several shards and distributes the verification of transactions over multiple nodes at the same time. Furthermore, The network is separated into zones based on geography. each of which has a validating node that handles transactions coming from inside it. Transactions made by participating members are saved in their shard after verification (local ledgers). A legal transaction needs to adhere to the rules set out by the governing board and have a predefined set of fields. Customers can access the product ledger using the query manager. is updated by native ledgers that are periodically duplicated and transmitted to the global validator.

Based on BC, Hossein et al. [67] put up a conceptual model in the agriculture sector to increase the level of trust between distributors and customers. The three tasks in this framework are tracing, verification, and registration. The participant registration process is handled by the administrative node.

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Utilizing smart contracts, one may handle the uploaded data verification process. In order to track the history of an object, The end user typically handles tracing, or customers. A food supply exchange system allowed by BC was proposed by Mao et al. [126]. Consequently, they put forth an algorithmic method based on dynamic programming to identify a middle ground between suppliers and buyers that optimizes transaction profitability. In this application domain, BC may be utilized to improve the monitoring component based on certain conditions. A proper credential scheme must be created if a public BC is to be utilized, as the source of the data on the BC must be readily identifiable.

A common food safety tracking system founded in BC and EPCIS was proposed by Feng et al. [40]. This system used smart contracts to solve issues like trust transfer and data corruption. In order to solve the problem of data explosion, On-chain and off-chain dynamic data management strategies are also used in this architecture. Perboli et al. [50] looked at a method that used smart contracts and blockchain technology to increase logistic visibility and transparency for soybeans. Business transactions are carried out using smart contracts. Thus, all transactions between participants Smart contracts will regulate and control the soybean supply chain. rather than by a reliable centralized authority. The BC, which is connected to the IPFS, stores these conversations. The logistic for soybeans is traceable and transparent in a secure and reliable way because of the link between IPFS and the BC.

Yasmin et al. [127] introduce a simplified blockchain (BC) design integrated with an IoT network for automation in the food sector, named Smart Food Chain (SFC). This model introduces the concept of Sub-BC, aimed at reducing resource utilization and processing complexity, in contrast to the conventional BC system. Next, Shivendra et al. [128] provide a blockchain-based crop pricing and traceability tracking method that efficiently manages company activities across the agricultural supply chain. Next, an Ethereum-based reputation system for the food and agriculture supply chains was proposed by Ilhaam et al. [51].

Because to BC, It has been demonstrated that the food logistic is more sustainable, enabling more effective operations and focused product recalls. When product information on BC is recorded in real-time, stakeholders will be able to respond to issues more quickly and comprehend product flow better. Wal-Mart developed a mango-tracking system, technology that can monitor a product enhancing product traceability from farm to shop in two seconds as opposed to seven days [38]. A number of other large IT companies have also created other BC systems or platforms for the food sector. Farm productivity may be increased by incorporating precision agricultural techniques and smart farming with BC, which guarantees data protection and integrity; it builds confidence among parties and expedites the whole process, simplifying the food supply chain; and, last but not least, it allows farmers to maximize their income through a reliable channel [129].

II. Chain of Pharmaceutical Supplies

Patients receive their prescription medications via the pharmaceutical supply chain. Medicine components are usually gathered from a variety of sources prior to being combined into the final preparation. pharmaceuticals. The Organization for Economic Cooperation and Development estimates that 3.3% of the global trade in prescription medications consists of counterfeit goods (OECD). Experts warn that the sale of fake pharmaceuticals is a serious problem. BC-enabled medication tracing may be used to establish a distributed, shared data platform for an unchangeable, reliable, responsible, and transparent system in the pharmaceutical logistic[57]. Because BC is Being auditable, transparent, and unchangeable, it can enhance the functionality of the pharmaceutical logistic system. It can also lessen logistic system theft and counterfeiting while aiding in inventory control.

The Modum.io Pharma logistic chain traceability solution, which blends the benefits of BC with IoT, was presented by Bocek et al. [130]. The back-end, a user interface, and Internet of Things sensor devices make up the system's architecture. The Ethereum BC and a server node, which are in charge of keeping an eye on the BC and carrying out smart contracts, make up the back end. Sensitive information can also be kept on this server. Smartphones running Android connect to the back-end server as the front end. [131] created Gcoin, a conceptual framework for the pharmaceutical logistic enabled by BC that tracks the shipment and distribution of medications. According to Tahseen et al. [114], it is recommended to use Internet of Things (IoT) sensors to monitor the position, humidity, and temperature of the carrier in order to maximize vaccine coverage in remote places while preserving transparency. In order to address issues related to vaccine expiry and fraudulent vaccination records, [25] created "vaccine BC" technology, which leverages the BC technology's smart contracts and traceability capability.

Using BC technology, Yaoming et al. [113] assess and develop a complete life cycle logistic management (SCM) strategy for medical equipment that addresses every stage of production, acquisition, preservation, utilisation, export, application, destruction, and tracking.

A medicine SCM system with BC enabled (MSCM) was proposed by [62] for the purpose of distributing medications across public health institutions in Indonesia. To find out if the recommended solution will work, the JMeter tool is used to assess the latency, resource consumption, and transactions per second (TPS) of the system.

A BC enabled Management System was developed by Kumiawan et al. [62] to detect fake goods inside the network of suppliers. Musamihand associates. [35] developed a

decentralised off-chain storage system and Ethereum-based blockchain for the pharmaceutical supply chain, enabling decentralised medication tracking and monitoring. Uddin and associates. [57] Two workable BC-based decentralised architectures that adhere to privacy, security, accessibility, and openness standards requirements are Hyperledger Fabric and Hyperledger Besu.

IV. CONCLUSION:

This study's objective is to give readers a brief overview of how BC technology functions and which situations call for its support while handling logistic problems. BC technology is used in several sectors for logistic management (SCM). This research investigates how blockchain technology and smart contracts are now being used in several important industrial fields. Based on scholarly research, the paper offers data on the general implementation BC's standing for different supply chains. The study's conclusions and outcomes show that supply chains in BC are a subject that is becoming increasingly popular. The vast majority of the reviewed and assessed articles concurred that BC might have advantages for the supply chain.

Additionally, an in-depth analysis of the potential, limitations, and future prospects of employing blockchain (BC) in the logistic is conducted to uncover unresolved research inquiries regarding the practical implementation of BC in the future. The advantages of blockchain (BC) technology might be undermined by a lack of comprehensive understanding. We believe that our study provides academics, engineers, educators, and general readers with a suitable introduction to the theoretical concepts of BC. Additionally, it delineates future research objectives in domains where BC intersects with emerging technologies.

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