

A STUDY ON ANALYSING THE IMPACT OF BLOCKCHAIN ON SUPPLY CHAIN TRANSPARENCY

Submitted in partial fulfilment of the requirements for the award of
Master of Business Administration

by

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SCHOOL OF BUSINESS ADMINISTRATION

SATHYABAMA

INSTITUTE OF SCIENCE AND TECHNOLOGY

(DEEMED TO BE UNIVERSITY)

Accredited with Grade "A" by NAACI 12B Status by UGC Approved by
AICTE Jeppiaar Nagar, Rajiv Gandhi Salai, Chennai - 600 119

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BONAFIDE CERTIFICATE

This is to certify that this Project Report is the Bonafide work of SIDDHARTHAAN K S (42410056) who carried out the project entitled "A Study on Analysing the Impact of Blockchain on Supply Chain Transparency" under my supervision from November 2023.

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DECLARATION

I **SIDDHARTHAAN KS (42410056)** hereby declare that the Project Report entitled “**A Study on Analysing the Impact of Blockchain on Supply Chain Transparency**” done by me under the guidance of **Dr . K. SEETHAL, M.Com, PhD, Assistant Professor, School of Management** at **SATHYABAMA INSTITUTE OF SCIENCE AND TECHNOLOGY, CHENNAI** is submitted in partial fulfilment of the requirements for the award of Master of Business Administration degree.

DATE:

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SIDDHARTHAAN KS

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EXECUTIVE SUMMARY

Blockchain's buzz makes it sound like a panacea. Another day, another new technology to consider. This time it's blockchain, the technology that was created to support bitcoin transactions. According to its cheerleaders, especially in the financial sector, blockchain technology has the potential to turbocharge the effectiveness and profitability of most (if not all) businesses — or even upend business as we know it. In fact, say these early adopters, businesses that ignore blockchain technology do so at their peril.

Strong words, but how true are they? Does blockchain technology really apply to the supply-chain world? Can it solve your supply-chain problems and increase your profitability? These are some of the very practical questions we've been asked by supply-chain executives. Our goals are to give you a clearer understanding of what blockchain technology is all about, and to save you the time of studying, testing, and assessing its value to your operations.

This analysis explores the transformative influence of blockchain technology on supply chain transparency. Highlighting key findings, it elucidates how blockchain ensures heightened traceability, accountability, and efficiency within supply chains. Emphasizing its implications, the study advocates collaborative initiatives and continuous innovation as crucial elements for leveraging blockchain's potential in reshaping transparent and trustworthy supply chains.

This abstract encapsulates the essence of the analysis, providing a concise overview of the research focus and its main conclusions regarding blockchain's impact on supply chain transparency.

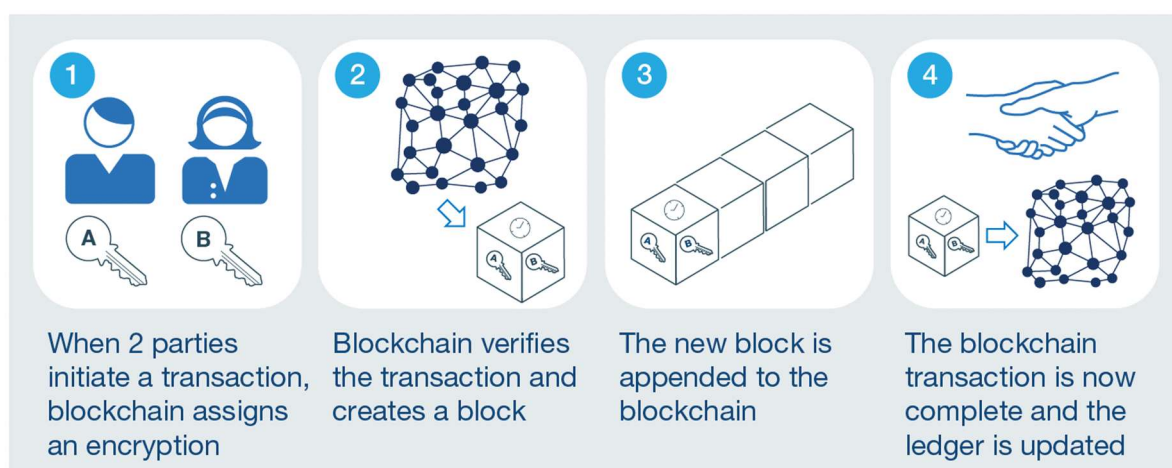
COMPREHENSIVE

1. Understanding blockchain technology

Blockchain is an internet-based technology that is prized for its ability to publicly validate, record, and distribute transactions in immutable, encrypted ledgers. The technology was invented to support transactions in bitcoin, a digital cryptocurrency that operates independently from a central bank. In essence, blockchain technology provides the platform for creating and distributing the ledger, or record, of every bitcoin transaction to thousands, if not millions, of computers linked to networks in all parts of the world.

Because the transactions and ledgers are encrypted, blockchain technology offers more security than the banking model, and its instantaneous transmission via the internet eliminates banks' two- to three-day clearing process and accompanying costs for transferring money from one account to another. The term "blockchain" is derived from the "blocks" of validated and immutable transactions and how they link together in chronological order to form a chain (exhibit). Hence the term "blockchain."

How to create a blockchain transaction



1.1. Characteristics of blockchain

The characteristics of blockchain which make it unique and promising for future industrial applications are:

- a) Decentralized: The data on the system can be accessed, monitored, stored and updated on multiple systems.
- b) Transparent: Data is recorded and stored on the network, with consensus from the network and is visible and traceable throughout its lifetime.
- c) Immutable: Blockchain provides timestamps and controls to ascertain immutability
- d) Irreversible: For every transaction ever made, a certain and verifiable record is kept in each blockchain.
- e) Autonomy: Each node on the blockchain can access, transfer, store and update data by itself safely without third party intervention.
- f) Open source: Blockchain provides open-source access to everyone in the network with sense of hierarchy.
- g) Anonymity: As data transfer occurs between nodes, the identity of the individual remains anonymous.
- h) Ownership and uniqueness: Every document exchanged on the blockchain stores its ownership records with a unique hash code
- i) Provenance: Every product has a digital record document in the blockchain which proves its authenticity and origin.
- j) Contract automation (i.e., smart contracting): It is a small computerized program to help execute contract. It replaces the need of a usual contract with providing better security and lower transaction costs. Smart contracts are usually coded to include conditions for rules, penalties and actions that will be applied for all the parties involved in the transaction. Smart contracting supports quick response operations in supply chains.

1.2. Blockchain architecture

It consists of five modules that govern the respective operations and create protocols for blockchain applications.

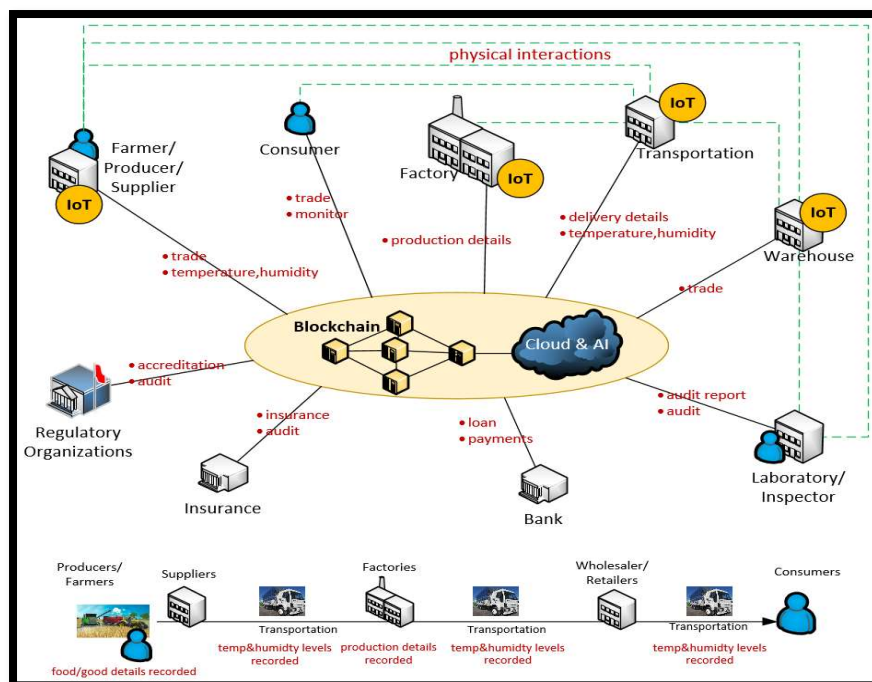
- **Data source module:** It helps create the blockchain in the “distributed and shared databases”. It ensures that the data retrieved by the users of the blockchain would be unaltered and uncorrupted. Note that data immutability, tamper-proofed storage with any form and shared data ledger through data “Application Programming Interface (API)” are the key aspects of blockchain.
- **Transaction module:** It monitors, manages, enables and supports the “journey of a transaction in blockchain”. It helps to validate and facilitate addition to the blockchain. Though smart contracting transaction gates, data are transferred. Along with shared visibility of transactions, the flow of information across the SC is constituted through the blockchain. Transactions are bundled and delivered to each node in the form of a block. Note that transactions once executed are almost impossible to delete or roll back in blockchains.
- **Block creation module:** Blocks can be regarded as data structures created by the miners. They contain information and details of transactions that are replicated to all nodes of the network. The block creation module enables the addition of new blocks to an existing SC by providing hash values and connections of the previous block. The sequences of transactions are saved in “chronological blocks” and blocks that store invalid transactions can be identified and tracked easily.
- **Consensus module:** Proof of work and proof of state algorithms are used to confirm and validate all the transactions to avoid corruption of data. Data consistency is maintained in the distributed network through the carefully designed “consensus algorithms”. Distributed consensus helps in both verification of the validity of transactions and link creation among the blocks in the blockchain system.
- **Connection and interface module:** It monitors the tracking of transactions and helps provide real time data on smart contracts. This module synchronizes all the information technology (IT) platforms, algorithms and software required for blockchain applications. Depending upon the use cases, multiple distributed ledger platforms could be made available in the market that offer

consensus algorithms for the blockchain system, no matter whether the blockchain is public, private, permissioned or non-permissioned.

2. Introduction to blockchain technology in supply chain

Blockchain technology has emerged as a transformative tool in revolutionizing supply chain management by offering unparalleled transparency, security, and traceability. At its core, blockchain is a decentralized, immutable ledger that records transactions across a network of computers. In the context of the supply chain, it serves as a shared, distributed database that enables the recording of transactions and data in a secure, transparent, and tamper-proof manner.

The application of blockchain in supply chains involves creating a digital ledger where information regarding the production, movement, and transactions of goods is stored in blocks that are linked together chronologically. Each block contains a unique cryptographic hash of the previous block, forming an unbroken chain. This design ensures that once information is recorded, it cannot be altered retroactively without changing all subsequent blocks, making the system highly secure and resistant to tampering.



Key elements of using blockchain in the supply chain include

1. **Transparency and Traceability:** Blockchain enables real-time tracking of products from their origin through every stage of the supply chain. Each participant can access a transparent record of transactions, verifying the authenticity and provenance of goods.
2. **Improved Efficiency:** The automation and digitization of processes through blockchain reduce paperwork, streamline operations, and minimize errors, resulting in increased efficiency and cost savings.
3. **Enhanced Security:** The decentralized nature of blockchain makes it extremely secure. Data stored on the blockchain is encrypted and distributed across multiple nodes, making it resistant to hacking or data manipulation.
4. **Smart Contracts:** These self-executing contracts are embedded in the blockchain and automatically execute when predefined conditions are met. In supply chains, smart contracts can facilitate and enforce agreements between parties, such as payment upon delivery or quality standards.
5. **Supply Chain Financing:** Blockchain facilitates easier access to financing by providing a transparent and immutable record of transactions, which can be used for trade finance and supply chain financing.
6. **Counterfeit Prevention:** By enabling transparent tracking of products, blockchain helps in preventing counterfeiting by ensuring the authenticity of goods at every stage of the supply chain.

2.1. How blockchain can improve the existing limitations of supply chains

Supply chain participants	Current limitations	Blockchain impact
Producer	Lack of ability to prove the origin and quality metrics of products transparently	Benefits from increased trust of keep track of the production raw material and value chain from producer to consumer
Manufacturer	Limited ability to monitor the product to the final destination. Limited capabilities of checking quality measured from raw material.	Added value from shared information system with raw material suppliers and distribution networks
Distributor	Custom tracking systems with poor collaboration capabilities. Limited certification ability and trust issues.	Ability to have proof-of-location and conditions certifications registered in the ledger.
Wholesaler	Lack of trust and certification of the products' path.	Ability to check the origin of the goods and the transformation /transportation conditions.
Retailer	Lack of trust and certification of the products' path. Tracking of products between consumers and wholesalers.	Ability to handle effectively the return of malfunctioning products.
Consumer	Lack of trust regarding the compliance of the product with respect to origin, quality and compliance of the product to the specified standards and origin.	Full and transparent view on the product origin and its whole journey from raw material to final, purchased product.

2.2. Track and Trace with Blockchain

Blockchain technology can be used to build applications on which multiple parties can transact directly via a peer-to-peer network, without the need for a central authority to verify transactions. Each network participant has access to a shared ledger that immutably and cryptographically records all transactions, and there is no single network owner.

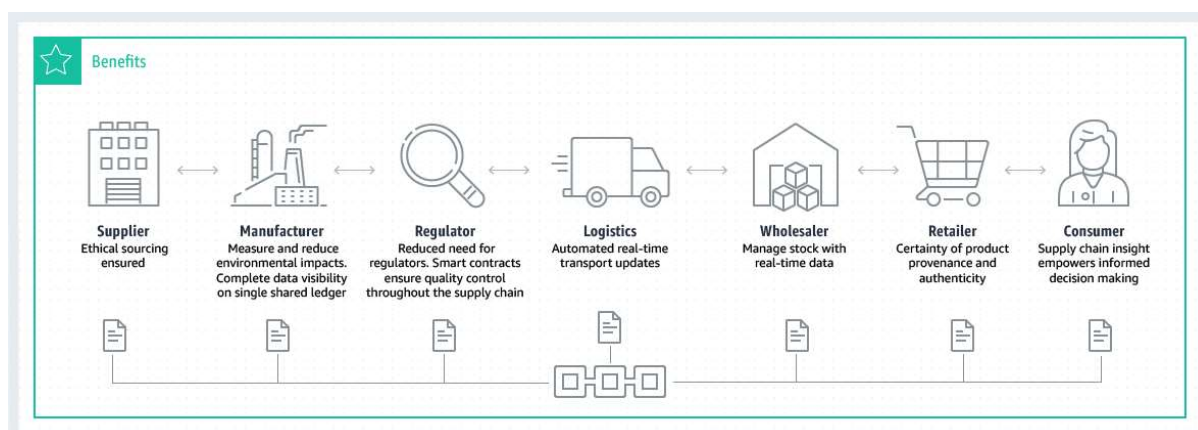
With blockchain, supply chain companies can document production updates to a single shared ledger, which provides complete data visibility and a single source of truth. Because transactions are always time-stamped and up to date, companies can query a product's status and location at any point in time. This helps to combat issues like counterfeit goods, compliance violations, delays, and waste. In addition, immediate action can be taken during emergencies (e.g., in the case of product recalls), and regulatory compliance is ensured by the ledger audit trail. Moreover, by combining blockchain with smart technology like Internet of Things, supply chains can automate tracking the conditions of

production, transportation, and quality control. Companies can also choose to share track and trace data with their customers as a way to verify product authenticity and ethical supply chain practices.

Traditional Supply Chains



Supply Chains with Blockchain



3. Supply chain Transparency

Supply chain transparency refers to the practice of openly and accurately disclosing information about products, processes, suppliers, and the overall supply chain. It involves providing visibility into the origin, production, distribution, and environmental/social impact of goods, aiming to enhance accountability, sustainability, and ethical standards

within the supply network. Transparency enables businesses, consumers, and stakeholders to make informed choices, promote responsible practices, and address issues like human rights violations, environmental sustainability, and product quality.

3.1. Significance of Supply chain Transparency

Supply chain transparency holds immense significance across various dimensions:

1. **Ethical Practices:** It enables companies to ensure ethical practices are upheld throughout the supply chain. This includes fair treatment of workers, adherence to labour laws, and ethical sourcing of materials, fostering a responsible business image.
2. **Consumer Trust and Loyalty:** Transparent supply chains build trust with consumers. When companies openly share information about their processes and sourcing, consumers feel more confident in their purchases, leading to increased loyalty.
3. **Risk Mitigation:** Transparency helps identify and mitigate risks, whether they are related to disruptions in the supply chain, compliance issues, or environmental concerns. Knowing the full scope of operations allows for better risk management strategies.
4. **Regulatory Compliance:** Many industries are subject to strict regulations concerning product sourcing, manufacturing, and distribution. Transparency ensures compliance with these regulations, reducing the risk of fines or legal issues.
5. **Sustainability:** With growing concerns about environmental impact, transparency allows companies to assess and improve their sustainability efforts. It enables tracking the carbon footprint, promoting eco-friendly practices, and reducing waste.
6. **Supplier Relationships:** Transparency fosters stronger relationships with suppliers. By openly sharing information and working collaboratively, companies can build more resilient and efficient supply chains.
7. **Brand Reputation:** A commitment to transparency positively impacts brand reputation. Being known for ethical practices and transparency attracts consumers who prioritize these values.

3.2. Blockchain's value in today's supply chains

In most cases, today's supply chains operate at-scale without blockchain technology. Even so, the technology has excited the IT and supply-chain worlds. It has also inspired many articles and prompted established IT players and start-ups to initiate promising pilot projects, including:

- Walmart tested an application that traces pork in China and produce in the US, to authenticate transactions and the accuracy and efficiency of record keeping.
- Maersk and IBM are working on cross-border, cross-party transactions that use blockchain technology to help improve process efficiency.
- BHP is introducing a blockchain solution that replaces spreadsheets for tracking samples internally and externally from a range of providers.
- Provenance, a UK start-up, just raised \$800,000 to adapt blockchain technology to trace food. It previously piloted tracing tuna in the Southeast Asian supply chain.

Yet to date, the authors are not aware of any at-scale applications to the supply chain, raising an essential question: Can blockchain technology add value to supply chains?

Let's start with a reality check: As most practitioners know, many of today's supply chains have good data, which they are able to transfer across supply chain tiers at close to real time speed. To assess blockchain technology's value at stake for the supply chain world, we looked at three areas where it could add value:

1. Replacing slow, manual processes. Although supply chains can currently handle large, complex data sets, many of their processes, especially those in the lower supply tiers, are slow and rely entirely on paper – such as is still common in the shipping industry.
2. Strengthening traceability. Increasing regulatory and consumer demand for provenance information is already driving change. Moreover, improving traceability also adds value by mitigating the high costs of quality problems, such as recalls, reputational damage, or the loss of revenue from black- or grey-market products. Simplifying a complex supply base offers further value-creation

opportunities (see sidebar, "A complex supply chain of unknown parties").

3. Reducing supply-chain IT transaction costs. At this stage, this benefit is more theoretical than actual. Bitcoin pays people to validate each block or transaction, and requires people who propose a new block to include a fee in their proposal. Such a cost would likely be prohibitive in supply chains because their scale can be staggering. For example, in a 90-day period, a single auto manufacturer would typically issue approximately 10 billion call-offs just to its tier-one suppliers. Also, together all of those transactions would significantly raise demand for data storage, an essential component of blockchain's distributed-ledger approach. In addition, creating and maintaining numerous copies of data sets would be impractical in the supply-chain environment, especially in permissionless blockchains.

4. Benefits of Blockchain in Supply chain

a) Enhanced security

Your data is sensitive and crucial, and blockchain can significantly change how your critical information is viewed. By creating a record that can't be altered and is encrypted end-to-end, blockchain helps prevent fraud and unauthorized activity. Privacy issues can also be addressed on blockchain by anonymizing personal data and using permissions to prevent access. Information is stored across a network of computers rather than a single server, making it difficult for hackers to view data.

Blockchain technology produces a structure of data with inherent security qualities. It's based on principles of cryptography, decentralization and consensus, which ensure trust in transactions. In most blockchains or distributed ledger technologies (DLT), the data is structured into blocks and each block contains a transaction or bundle of transactions. Each new block connects to all the blocks before it in a cryptographic chain in such a way that it's nearly impossible to tamper with. All transactions within the blocks are validated and agreed upon by a consensus mechanism, ensuring that each transaction is true and correct.

Blockchain technology enables decentralization through the participation of members across a distributed network. There is no single point of

failure and a single user cannot change the record of transactions. However, blockchain technologies differ in some critical security aspects.

How fraudsters attack blockchain technology?

Hackers and fraudsters threaten blockchains in four primary ways: phishing, routing, Sybil and 51% attacks.

✓ Phishing attacks

Phishing is a scamming attempt to attain a user's credentials. Fraudsters send wallet key owners emails designed to look as though they're coming from a legitimate source. The emails ask users for their credentials using fake hyperlinks. Having access to a user's credentials and other sensitive information can result in losses for the user and the blockchain network.

✓ Routing attacks

Blockchains rely on real-time, large data transfers. Hackers can intercept data as it's transferring to internet service providers. In a routing attack, blockchain participants typically can't see the threat, so everything looks normal. However, behind the scenes, fraudsters have extracted confidential data or currencies.

✓ Sybil attacks

In a Sybil attack, hackers create and use many false network identities to flood the network and crash the system. *Sybil* refers to a famous book character diagnosed with a multiple identity disorder.

✓ 51% attacks

Mining requires a vast amount of computing power, especially for large-scale public blockchains. But if a miner, or a group of miners, could rally enough resources, they could attain more than 50% of a blockchain network's mining power. Having more than 50% of the power means having control over the ledger and the ability to manipulate it.

Note: Private blockchains are not vulnerable to 51% attacks.

In today's digital world it is essential to take steps to ensure the security of both your blockchain design and environment. X-Force Red blockchain testing services can help you do just that.

Blockchain security for the enterprise

When building an enterprise blockchain application, it's important to consider security at all layers of the technology stack, and how to manage governance and permissions for the network. A comprehensive security strategy for an enterprise blockchain solution includes using traditional security controls and technology-unique controls. Some of the security controls specific to enterprise blockchain solutions include:

- Identity and access management
- Key management
- Data privacy
- Secure communication
- Smart contract security
- Transaction endorsement

Employ experts to help you design a compliant and secure solution and help you achieve your business goals. Look for a production-grade platform for building blockchain solutions that can be deployed in the technology environment of your choosing, whether that is on-premises or your preferred cloud vendor.

Blockchain security tips and best practices

When designing a blockchain solution, consider these key questions:

- What is the governance model for participating organizations or members?

- What data will be captured in each block?
- What are the relevant regulatory requirements, and how can they be met?
- How are the details of identity managed? Are block payloads encrypted? How are the keys managed and revoked?
- What is the disaster recovery plan for the blockchain participants?
- What is the minimal security posture for blockchain clients for participation?
- What is the logic for resolving blockchain block collisions?

When establishing a private blockchain, ensure that it's deployed in a secure, resilient infrastructure. Poor underlying technology choices for business needs and processes can lead to data security risks through their vulnerabilities.

Consider business and governance risks. Business risks include financial implications, reputational factors and compliance risks. Governance risks emanate primarily from blockchain solutions' decentralized nature, and they require strong controls on decision criteria, governing policies, identity and access management.

Blockchain security is about understanding blockchain network risks and managing them. The plan to implement security to these controls makes up a blockchain security model. Create a blockchain security model to ensure that all measures are in place to adequately secure your blockchain solutions.

To implement a blockchain solution security model, administrators must develop a risk model that can address all business, governance, technology and process risks. Next, they must evaluate the threats to the blockchain solution and create a threat model. Then, administrators must define the security controls that mitigate the risks and threats based on the following three categories:

- Enforce security controls that are unique to blockchain

- Apply conventional security controls
- Enforce business controls for blockchain

b) Instant traceability

Blockchain creates an audit trail that documents the provenance of an asset at every step on its journey. In industries where consumers are concerned about environmental or human rights issues surrounding a product or an industry troubled by counterfeiting and fraud, this helps provide the proof. With blockchain, it is possible to share data about provenance directly with customers. Traceability data can also expose weaknesses in any supply chain where goods might sit on a loading dock awaiting transit.

c) Increased efficiency and speed

Traditional paper-heavy processes are time-consuming, prone to human error, and often requires third-party mediation. By streamlining these processes with blockchain, transactions can be completed faster and more efficiently. Documentation can be stored on the blockchain along with transaction details, eliminating the need to exchange paper. There's no need to reconcile multiple ledgers, so clearing and settlement can be much faster.

d) Automation

Transactions can even be automated with "smart contracts," which increase your efficiency and speed the process even further. Once pre-specified conditions are met, the next step in transaction or process is automatically triggered. Smart contracts reduce human intervention as well as reliance on third parties to verify that terms of a contract have been met. In insurance, for example, once a customer has provided all necessary documentation to file a claim, the claim can automatically be settled and paid.

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Smart contracts are simply programs stored on a blockchain that run when predetermined conditions are met. They typically are used to automate the execution of an agreement so that all participants can be immediately certain of the outcome, without any intermediary's involvement or time loss. They can also automate a workflow, triggering the next action when conditions are met.

How smart contracts work

Smart contracts work by following simple “if/when...then...” statements that are written into code on a blockchain. A network of computers executes the actions when predetermined conditions have been met and verified. These actions could include releasing funds to the appropriate parties, registering a vehicle, sending notifications, or issuing a ticket. The blockchain is then updated when the transaction is completed. That means the transaction cannot be changed, and only parties who have been granted permission can see the results.

Within a smart contract, there can be as many stipulations as needed to satisfy the participants that the task will be completed satisfactorily. To establish the terms, participants must determine how transactions and their data are represented on the blockchain, agree on the “if/when...then...” rules that govern those transactions, explore all possible exceptions, and define a framework for resolving disputes.

Then the smart contract can be programmed by a developer – although increasingly, organizations that use blockchain for business provide templates, web interfaces, and other online tools to simplify structuring smart contracts.

Benefits of smart contracts

❖ Speed, efficiency and accuracy

Once a condition is met, the contract is executed immediately. Because smart contracts are digital and automated, there's no paperwork to process and no time spent reconciling errors that often result from manually filling in documents.

❖ Trust and transparency

Because there's no third party involved, and because encrypted records of transactions are shared across participants, there's no need to question whether information has been altered for personal benefit.

❖ Security

Blockchain transaction records are encrypted, which makes them very hard to hack. Moreover, because each record is connected to the previous and subsequent records on a distributed ledger, hackers would have to alter the entire chain to change a single record.

❖ Savings

Smart contracts remove the need for intermediaries to handle transactions and, by extension, their associated time delays and fees.

How industries benefit from blockchain

➤ Blockchain benefits in supply chains and food chain

Building trust between trading partners, providing end-to-end visibility, streamlining processes, and resolving issues faster with blockchain all add up to stronger, more resilient supply chains and better business relationships. Plus, participants can act sooner in the event of disruptions. In the food industry, blockchain can help ensure food safety and freshness, and reduce waste. In the event of contamination, food can be traced back to its source in seconds rather than days.

➤ Banking and financial industry blockchain benefits

When financial institutions replace old processes and paperwork with blockchain, the benefits include removing friction and delays, and

increasing operational efficiencies across the industry, including global trade, trade finance, clearing and settlement, consumer banking, lending, and other transactions.

➤ Healthcare blockchain benefits

In an industry troubled by data breaches, blockchain can help healthcare improve security for patient data while making it easier to share records across providers, payers and researchers. Control over access remains in the hands of the patient, increasing trust.

➤ Pharmaceutical blockchain benefits

As pharmaceutical products move through the supply chain, every action is recorded. The resulting audit trail means an item can be traced from origin to pharmacy or retailer, helping to prevent counterfeiting and enabling manufacturers to locate a recalled product in seconds.

➤ Government blockchain benefits

Blockchain can help governments work smarter and innovate faster. Secure sharing of data between citizens and agencies can increase trust while providing an immutable audit trail for regulatory compliance, contract management, identity management, and citizen services.

➤ Insurance blockchain benefits

Insurance companies are using blockchain and smart contracts to automate manual and paper-intensive processes such as underwriting and claims settlement, increasing speed and efficiency, and reducing costs. Blockchain's faster, verifiable data exchanges help reduce fraud and abuse.

5.Challenges

5.1. Organizational challenges

While benefits are manifold, several inter-organizational, intra-organizational, technical and external barriers hamper full-scale adoption. The various factors that influence adoption are organizational

readiness, technical expertise, digital infrastructure, scalability issues, financial resources, legal and regulatory compliance, organizational resistance, performance expectancy, standardization, security of models, and country of business. Local and national laws often become a roadblock for blockchain innovations and hence there is an increasing need for involving government agencies for rules and regulation compliance while developing new blockchain based solutions. Also, consumer awareness and empowerment play a major role in the adoption of a new technology as consumers as well as employees will have to change the way of purchasing/operations. Among these, organizational readiness and regulation are the least explored areas and need to be changed drastically in order for blockchain to have a broader reach and coverage.

Observe that the legal aspects of business and regulatory framework are inevitable. The implementation of smart contracting systems in logistics by taking into account of all these issues must be researched further in the future. Hence, this should be kept in mind while designing the blockchain platforms for effective performance of smarting contracting. The reluctance of organizations to share the information on a global platform is still a major obstacle. Issues like lack of common standard across different organizations act as a hindrance in scaling up and would lead to interoperability issues. The government and industry both need to work together for the development of a common standard to solve the issue.

5.2. Technical challenges

Although blockchain is known to be tamper-proofed data storage infrastructure and one of the highly secured transaction platforms, the block size in the blockchain can be a limiting factor in terms of performance and efficient utilization of the platform.

The biggest blockchain barrier: who would give permission?

In adopting blockchain technology for its supply chain, a company must first decide on the type of blockchain it would need to build. Recall that the bitcoin approach is a permissionless blockchain populated with parties that are not known or trusted. It resides in the public domain and uses a consensus verification protocol to establish trust in each block. There is no central database or central governance in these blockchains.

A bias for privacy

Conversely, in most supply chains, the parties are known and trusted. Moreover, the supply-chain world is unlikely to accept open access because its users don't want to reveal proprietary details, such as demand, capacities, orders, prices, margins, at all points of the value chain to unknown participants. This means most supply-chain blockchains would need to be permissioned, with access governed centrally and restricted to known parties who may be limited to certain segments of data.

In theory, this approach allows public or private verification of each proposed block. However, we believe it is unlikely that we will ever see public verification of proposed blocks in the supply-chain world when all the parties are known. In shipping, for example, there are only a few known parties in the chain—including haulers, ports, customs, shipping lines—that are responsible for validating each block. When the number of trusted parties is small, the need to independently validate consensus protocols used in the public domain is limited.

In many cases, supply chains are already moving billions of transactions and data, often in real time. The systems are not perfect, and many supply chains have issues with data that is siloed, disparately formatted, difficult to access, or hard to visualize or analyse in the context of big data. Even so, well-managed central databases with good data management, combined with supply-chain visualization and analytical prowess, can be achieved at scale today.

These solutions do not carry the additional burden of some of the technical complexities that blockchain can raise. Thus, we maintain that when all parties in extended supply chains are known and trusted, a blockchain solution is probably not needed, as these known and trusted parties can be relied upon to provide a single, real-time version of the truth. In such a situation, centralized solutions like a cloud-portal, or decentralized peer-to-peer connections would suffice.

Some of the technical challenges that are often faced while operating blockchain enabled SC operations are listed below

Scalability: Some of the major scalability issues in blockchain implementation are chain limitations with ever increasing number of transactions, big block sizes, long response time and high fees. When the

number of users is increasing day by day, the challenges in blockchain scalability are also increasing.

Privacy: Though the data security, storage and management are some of the key features of data management in blockchains, data privacy and confidentiality are still sources of problems. This is especially true for the public blockchain when data and many privacy related details are stored as a public ledger.

Interoperability: Exchanges of information for different block transactions or making use of information by different blockchain systems are an important interoperable architecture in blockchains and. When the number of blockchain applications is growing at a faster rate, interoperability issue is also getting more serious

Product provenance: Product history, origin and traceability in blockchain are termed as product provenance, which is a critical part of blockchain. How to properly and accurately present the product provenance information is critically important.

Latency: The transaction rate or each bitcoin block processing time along with security check takes several minutes which shows that blockchain architectures would face serious latency challenges.

Auditing, visibility and disintermediation are some other important features of blockchain technology that require a careful monitoring for error free verification and auditability, easy tracking and no mediation of third party which can lead to uninterrupted and trusted transactions.

5.3. Operational challenges

When it comes to SC operations and logistics management, old challenges like damaging of raw materials and products, erroneous data entry, order mismanagement, etc. are still present. The effective implementation and smooth functioning of blockchain in SC systems would require the proper involvement and participation of various parties including global logistics partners, operational efficiency, maintenance costs, big data management, and IT support. Apart from these, government regulations on cryptocurrency, data warehousing, scalability and highspeed internet

connectivity with enormous computing power are real challenges. Blockchain requires every transaction to be processed and validated through each node; and in developing and under developed nations, poor infrastructure and the abovementioned constraints can defeat the purpose of blockchain implementation goals. Moreover, adaptability, standardization, expandability, and synergy between different technologies are other challenges and need to be researched upon.

Consider the facts before you jump on the blockchain bandwagon

Our research suggests that blockchain technology may ultimately be a good solution for some types of supply chains, but it is not yet ready for mass adoption. We base this view on the following:

- Blockchain pilots run to date have not proven the technology's unique value to the supply-chain sector
- Blockchain technology is not yet able to capture data across a high number of untrusted parties
- Delivering full transparency or traceability can be solved in other ways, not just by blockchain
- The cost of developing and running a blockchain is not yet clear, with few standards now in place
- The gap between blockchain's current capacity and the capacity that supply chains will need is enormous

For supply chains where participants are not known or trusted, blockchain technology can add trust, transparency, and traceability. Almost by definition, these supply chains are complex, multi-tiered, involve many parties, and they operate in a regulated environment that demands a higher level of traceability.

However, for supply chains with known and trusted players, a centralized database approach is generally more than adequate. This does not mean that all these supply chains currently follow a true end-to-end approach, and in fact, many of them use siloed databases that contain data with only limited traceability. Thus, many of these supply chains do not need blockchain technology to solve such issues, as they can leverage existing technologies that are better suited to their high-volume transactions, either on their own or with partners.

It's too early to estimate the costs of operating blockchain technology in the supply-chain world, and compare them with other technologies. No doubt, IT companies will be at the ready to provide this information.

However, the value proposition must be clear. What are the internal transactional efficiencies? What is the potential cost in end-product failures, recalls and litigation? Would a consumer pay more for a product that offers transparency throughout its supply chain? These types of questions should be asked when considering blockchain for use in supply chains.

A number of companies are exploring the benefits of leveraging blockchain technology in adjacent areas, such as introducing smart contracts, bringing more rigor to purchase order payments or demand chains where "real demand" signals can propagate the upstream supply chain faster. While we salute the power and the promise of blockchain technology, we advise the supply-chain world to take the time to measure its suitability against other, possibly simpler, and less costly technologies.

6. Case studies

6.1. CASE-1: DELOITTE-Using Blockchain and IOT for Shipment Tracking

OVERVIEW

Tracking parcels or shipments in real time is possible with modern delivery services; however, data is often tied to a specific company that manages the delivery chain. Valuable insights from collected data often end up in a centralized repository. But that limits their availability for analysis by multiple parties and represents a lost opportunity to optimize the management of the supply chain.

APPROACH

Deloitte worked with a client to develop real-time shipment tracking. To do that, Deloitte teams brought together a common blockchain platform—Hyperledger Fabric—which underpins Deloitte's supply chain prototype "Track and Trace," together with Thingstream, a real-time positioning tracker, and AWS technology. Strapped on to a pallet, a sensor records the location of a shipment over any GSM network, internationally. By tracking all data on a single ledger, the sender, shipper,

and receiver can build a trusted and immutable history of the shipment's life cycle.

IMPACT

The prototype allows real-time tracking of any object as it is shipped across borders and without the need for human intervention to update its location. Data is recorded immutably on a distributed ledger. And in a network at scale, that prevents a single actor from tampering with any data. This process is the first step in the creation of integrated end-to-end blockchain solutions for supply chains—solutions that can enable greater collaboration between parties and increased transparency throughout the value chain.

6.2. CASE-2: DELOITTE- A blockchain based proof of concept focused on simplifying patient consent and biological samples management in clinical trials

OVERVIEW

The complexity of biological sample (bio sample) collection and management raises many challenges for clinicians who lead trials and who need to guarantee patients' consent throughout the process.

APPROACH

To demonstrate the value of blockchain in solving these pain points, Deloitte teams developed a proof of concept (PoC) called Bio Track & Trace. The PoC brings consent, bio sample collection, bio sample storage, bio sample sharing, and analysis processes all on to the blockchain. This brings together the too often isolated processes as they are managed by doctors, clinical trial sites, biobank managers, and researchers. By tracking these processes on a single blockchain, operations teams and scientists can track a sample's location, understand how it was collected and used, and verify the level of consent the trial participant provided. Similarly, it allows trial participants to have greater control over their bio samples and gain insights into the results of their participation in the study. Bio Track & Trace ultimately improves tracking mechanisms, traceability, and consent management across the clinical trial's value chain.

IMPACT

Bio Track & Trace allows for any actor on the blockchain to track and trace bio samples and the consent provided by each trial participant. This is the

first step in the development of a broader, industrywide blockchain ecosystem that enables greater collaboration and alignment between the needs and demands of pharmaceutical companies, data standardization, analytics, patient-centricity and retention, process simplification, and cost reduction.

6.3. Case-3: IBM Sterling Supply Chain Intelligence Suite

IBM Sterling Supply Chain Intelligence Suite is an AI-based optimization and automation solution designed for organizations struggling to solve supply chain disruptions through traditional transformation. The products in the suite help facilitate a digital supply chain transformation, improving supply network resiliency and sustainability, increase agility and accelerate time-to-value through actionable insights, smarter workflows and intelligent automation.

Why IBM Sterling Supply Chain Intelligence Suite

- **2.2 seconds**-Reduce the time it takes to trace items from store to farm from 7 days to 2.2 seconds.
- **18% reduction**-Reduce inventory levels to save on waste and cost.
- **Days to hours**-Reduce time needed for critical supply chain disruption management from days to hours.

Features

- Real-time, multi-enterprise visibility

Identify and resolve critical supply chain issues faster with end-to-end visibility, advanced analytics and actionable workflows.

- Actionable insights, predictions and recommendations

Make informed decisions with more accessible real-time data. Act from the same dashboard, based on predictions and recommendations provided.

- Cross-functional workflow orchestration

Leverage the power of new technologies including open platforms, AI, IoT and automation to help customize workflows to predict, plan for and respond to complex supply chain challenges.

- Product-specific traceability

Trace and communicate product history more effectively. Monitor and alert on inventory age in real-time to maintain inventory freshness.

- Blockchain-backed immutability and trust

Benefit from a blockchain platform that enables companies to enhance their own data-sharing ecosystem with trusted supply chain partners.

- Solution extensibility

Easily extend and personalize the solution to gain new insights and automate actions with custom data processing rules, dashboards and work queues for a competitive advantage.

Use cases

- Inventory exception management- Detect out-of-stock and proactively take action to avoid fulfilment delays
- Manage outbound logistics - Detect and respond faster to shipment delays to mitigate customer impact
- Manage product recalls - Trace and communicate product history more effectively to control impact
- Eliminate inventory spoilage - Monitor and alert on inventory age in real-time to maintain inventory freshness
- Protect brand reputation - Track product authenticity and quality from origin to consumption to preserve brand equity
- Reduce supplier risk - Manage compliance by tracking agreements, contracts, policies, and credentials to reduce exposure from third parties

- Manage inbound supply disruptions - Detect upcoming delays in supply shipments due to weather and other risk events, to minimize line outages, manufacturing delays, and lost revenue.
- Drive Scope 3 accuracy - Inform ESG systems with comprehensive supplier data. Act on supplier ESG initiatives with operational dashboards

6.4. Case-4: How Walmart Brought Unprecedented Transparency to The Food Supply Chain with Hyperledger Fabric

Challenge

When an outbreak of a food-borne disease happens, it can take days, if not weeks, to find its source. Better traceability could help save lives by allowing companies to act faster and protect the livelihoods of farmers by only discarding produce from the affected farms.

Approach

Walmart thought that blockchain technology might be a good fit for the decentralized food supply ecosystem. To test this hypothesis, the company created a food traceability system based on Hyperledger Fabric. Walmart, together with its technology partner IBM, ran two proof of concept projects to test the system. One project was about tracing mangos sold in Walmart's US stores and the other aimed to trace pork sold in its China stores.

The Hyperledger Fabric blockchain-based food traceability system built for the two products worked. For pork in China, it allowed uploading certificates of authenticity to the blockchain, bringing more trust to a system where that used to be a serious issue. And for mangoes in the US, the time needed to trace their provenance went from 7 days to... 2.2 seconds!

Results

Walmart can now trace the origin of over 25 products from 5 different suppliers using a system powered by Hyperledger Fabric. The company

plans to roll out the system to more products and categories in the near future. In fact, it has recently announced that it will start requiring all of its suppliers of fresh leafy greens (like salad and spinach) to trace their products using the system.

For mangoes in the US, the time needed to trace their provenance went from 7 days to... 2.2 seconds!



The POCs

In October 2016, Walmart, together with its technology partner IBM, announced the two projects: one was about tracing the origin of mangos sold in Walmart's US stores and the other aimed to trace pork sold in its China stores.

For the mango POC, Yiannas started by creating a benchmark. He bought a packet of sliced mangoes at a nearby Walmart store and asked his team to identify which farm they had come from – as fast as possible. The team started calling and emailing distributors and suppliers, and eventually had an answer almost seven days later. This was not bad by industry standards, but Walmart wanted to do much better. So together with IBM, they got to work building a blockchain-based food traceability system.

The Walmart Technology team looked at their own processes as well as those of their suppliers to design the application. Archana Sristy, Director of Engineering at Walmart, explains, “[Our team at Walmart Technology] co-led the core design and setup of the application (with IBM), as well as built the integration with the enterprise systems. We worked with GS1 (the standards authority in barcodes and labelling) to define the data attributes for upload to the blockchain. IBM wrote the chain code.

Suppliers used new labels and uploaded their data through a web-based interface.

The Hyperledger Fabric blockchain-based food traceability system built for the two products worked. For pork in China, it allowed uploading certificates of authenticity to the blockchain, bringing more trust to a system where that used to be a serious issue. And for mangoes in the US, the time needed to trace their provenance went from 7 days to... 2.2 seconds!

From POC to production, from Walmart to IBM Food Trust

Once Walmart saw that the system worked, they wanted to expand it – and not just within Walmart. Given the interconnected nature of the food system and the company’s negative experience with closed systems, Walmart wanted to make sure that this time, many players were involved. Says Yiannas, “(Walmart’s) CEO was reaching out to other food companies the next day, including other retailers!” Wal-Mart collaborated with IBM and others to set up IBM Food Trust, involving prominent players in the food industry, like Nestle and Unilever.

The Walmart team had a positive experience working with Hyperledger. “Every question that we had, it looked like the Hyperledger community had already been working on addressing that,” says Bedwell. For example, in building a truly open system, the Walmart team worried about interoperability with other blockchain-based traceability systems. And as if in answer to their concern, Hyperledger recently announced its collaboration with Ethereum. He adds, “It seems that the Hyperledger community is addressing everything that enterprises would be concerned about.”

Says Yiannas, “I really had an ‘aha’ moment once I deeply understood the technology. I had been hesitant about creating yet another traceability system – the ones we had tried in the past never scaled. Now I understand that was because they were centralized databases. Blockchain, with its decentralized, shared ledger felt like it was made for the food system!”

Tips from Frank Yiannas on implementing your blockchain project

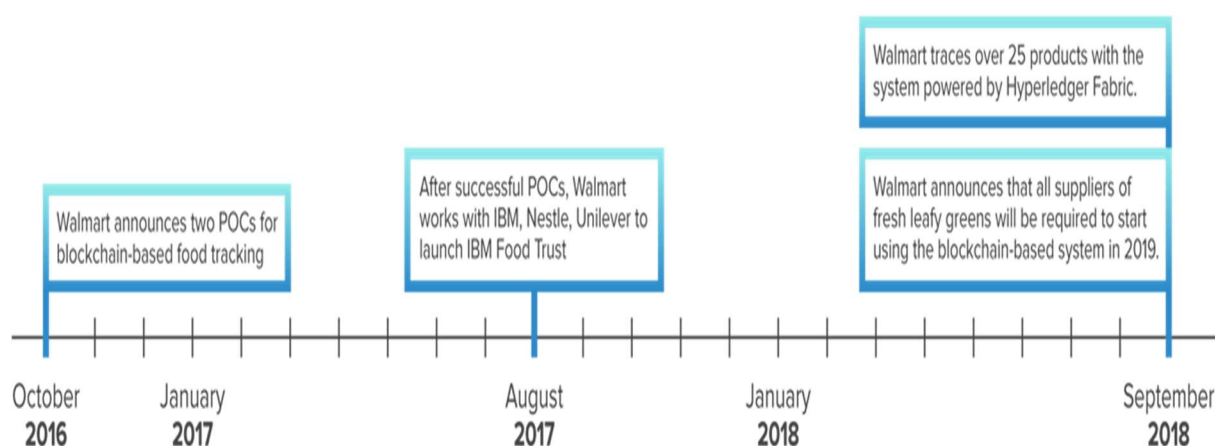
- 1. Let the business lead the project, not the IT department.**
- 2. Understand the business case deeply.** Make sure that you know and can explain why blockchain is the right solution.
- 3. In a large organization, you need to bring a lot of people along.** Think about all the different departments that will be affected by the projects.

Meet with these stakeholders early on and explain what you are trying to do.

4. Have your soundbite! People don't get inspired by technology, but by a vision. For us, it was the story of mangoes – 7 days vs. 2.2 seconds with blockchain.

5. Participate in forums that allow you to speak to other companies who have launched similar projects successfully.
It helps if you help an expert in the field who's willing to come in and educate fellow members.

6. Start small, with a POC. And when you've run your pilots and are convinced about the business value, go ahead and scale. After all, Yiannas says, "Walmart is a pretty big lab! If it can scale at Walmart, it can scale anywhere!"



Looking forward

Walmart now traces over 25 products from 5 different suppliers using IBM Blockchain which is built atop Hyperledger Fabric. The products include produce such as mangoes, strawberries and leafy greens; meat and poultry such as chicken and pork; dairy such as yogurt and almond milk; and even multi-ingredient products such as packaged salads and baby foods.

Yiannas says of the impact, "This solution allows us to see the whole chain in seconds! We can take a jar of baby food and see where it was manufactured and trace back all the ingredients to the farms!"

Walmart plans to roll out the system to more products and categories in the near future in cooperation with IBM Food Trust. In fact, the company recently announced that it will start requiring all of its suppliers of fresh leafy greens (like salad and spinach) to trace their products using the system.

“Using the IBM Food Trust network that relies on blockchain technology, we have shown that we can reduce the amount of time it takes to track a food item from a Walmart Store back to source in seconds, as compared to days or sometimes weeks,” Walmart wrote in a letter to suppliers.

Beyond tracing the products’ journey, the company might start tracing other data, like sustainability.

REVIEW OF LITERATURE

According to Swan M, Blockchain: Blueprint for a new economy-2015, Blockchain is a disruptive information technology and a validation of a shared digital ledger (either public or private) of all digital events across the participating agents and a new information flow and computing technology.

Based on the research work carried out by Saberi S, Kouhizadeh M, Sarkis J, Shen L- Blockchain Technology and its Relationships to Sustainable Supply chain management- 2019, BCT has a wide range of characteristics, some of which are Anonymity, Auditability, Autonomy, Contract Automation, Decentralized/non-localization, Immutable, Irreversible, Open-source, Ownership and Uniqueness, Provenance, Security, and Smart execution. The return of Blockchain-related initiatives in a certain country is affected to a great extent with the level of data restriction set in that given country, in addition to the strength of the research related to blockchain.

In the opinion of Moosavi J, Naeni L M, Fathollahi Fard A M- Blockchain in Supply chain Management: A Review bibliometric and network analysis- 2021, Blockchains have become pervasive in various areas, including but not limited to, healthcare, SCM, sustainable supply chain, circular supply chain, real estate, government, automotive industries, finance, auditing accounting, agriculture, education, and many more. Blockchains can make any institution or industry that requires record-keeping more efficient, transparent, and secure. Furthermore, examines the implications of BCT on value creation in the healthcare sector based on investigating 33 companies. An annual global survey for more than 1400 senior leaders revealed in the year 2020 that 39% of the respondents had brought Blockchain into production. In 2018, blockchain spending grew by 110%, and the financial sector alone contributed \$552 million to Blockchain projects. As a result, the Blockchain market grew dramatically from only a million in 2012 to almost 4.3 billion in 2018.

As stated by Dutta P, Choi T M, Somani S, Butala R- Blockchain Technology in Supply chain Operations- 2020, BCT disruptively changes the way traditional SCM runs, while concludes that technology is one of the main critical and dominant barriers for Blockchain in SCM that would

pose a threat specifically to industries with anxiety toward technology adoption. To illustrate the struggles of brick-and-mortar retailers (e.g., Macy's, J.C. Penny, Toys R US, etc.), cable T.V. service (e.g., Direct TV, Dish, etc.), traditional news media (e.g., local newspapers, etc.), and many others are creating a consensus of FOMO—fear of missing out—with technology adoption. Therefore, the advent of the Blockchain immediately drew public attention, and companies flocked to embrace the technology without hesitation. However, given the irrational pulse for technology adoption combined with the bewilderment of Bitcoin and Blockchain, many unsuccessful Blockchain projects emerged, and the failure rate is reported to be 92%

IoT and smart contracts are the leading technologies in using BCT for SCM. The electric power industry is ahead in the integration of BCT because of the advanced usage of smart contracts. Furthermore, BCT has a strong potential for fostering sustainable SCM.

Centobelli P, Cerchione R, Del Vecchio P- Blockchain Technology for bridging Trust, Traceability and Transparency in Circular Supply chain-2021, developed a framework for designing circular blockchain platforms. Trust, social influence, and effort expectancy are three facilitating conditions for BCT adoption. There are 53 applications for BCT toward SCM.

Babitch V, Hilary- Distributed ledgers and operations: What operations management researchers should know about Blockchain Technology-2020, identifies five strengths of Blockchain application from the operations management perspective, including visibility, aggregation, validation, automation, and resilience. On the other hand, BCT has a dark side; their study indicates five corresponding weaknesses: lack of privacy, lack of standardization, garbage in, garbage out, black box effect, and inefficiency.

RESEARCH METHODOLOGY

1.Need for Study:

- To study the impact of Block Chain Technology in Supply Chain Transparency
- Investigate how Blockchain Technology assists in ensuring compliance with regulations and standards, enhancing governance and accountability.
- Understanding Blockchain's impact can optimize supply chain operations, mitigate errors, and create more resilient and trustworthy systems in the increasingly complex global supply networks.

2.Scope of the Study:

- Supply Chain Efficiency – Analyzing the impact of Blockchain on optimizing processes, reducing delays, and cutting costs.
- Sustainability and Ethical Sourcing – Exploring how Blockchain can facilitate ethical sourcing and sustainability initiatives by providing a transparent record of product origins.

3.Objectives of the Study

- Identify and analyze specific use cases where Blockchain can be effectively applied in Supply chain operations to enhance transparency.
- Conduct a cost benefit analysis to determine the financial implications of adopting Blockchain technology in the Supply Chain.
- Develop metrics to quantify the level of transparency achieved through Blockchain implementation and assess its effectiveness.

4.Statement of Problem

Implementing Blockchain technology in Supply Chain Transparency comes with several challenges that need to be addressed for successful integration. The statement of the problem when considering Blockchain in Supply Chain Transparency revolves around

- Scalability of Networks: As the number of transactions increases, scalability becomes a concern, potentially slowing down the network and affecting efficiency.
- Lack of interoperability: Integration with existing systems and diverse blockchains might be challenging due to differing protocols, leading to interoperability issues.
- Security Vulnerabilities: While Blockchain is inherently secure, vulnerabilities in smart contracts, private keys, or coding errors could lead to security breaches.
- Fraud and Lack of Accountability: Instances of fraud, lack of accountability, and opaque processes within supply chains can compromise product quality, safety, and ethical standards.

5.Research Methodology

Research is the process of systematic and in-depth study or search for any particular topic, subject or area of investigation, backed by collection, compilation, presentation and interpretation of relevant details or data.

5.1. Research Process

In research process, the first and foremost step is defining and selecting a research problem. A Researcher should at first find the problem. Then he should formulate it so that it becomes susceptible to research. For a systematic presentation, the process of research may be classified under three stages-primary stages, secondary stage, and the tertiary stage.

The primary stage includes

- Observation
- Interest
- Formulating research problems
- Documentation
- Research designs

The secondary stage includes

- Project planning
- Data collection
- Questionnaire preparation
- Analysis of data
- Testing of hypothesis
- Interpretation
- Questionnaire preparation.

5.2. Type Of Research Descriptive Research

Descriptive research has been used, it involves survey and factfinding enquiries of different kinds, the purpose of descriptive research is the descriptive of state of affairs, as it exists at present.

5.3. Project Planning

Project planning is the first step in actually conducting & directing a research Project. It is one of the most important tasks of a researcher. This includes formulation of the objectives & goals and determining ways of achieving them.

5.4. Data Collection Data collection is one of the most important aspects of research. The information in tough research methodology must be accurate and relevant. The data collection method can be classified into two methods.

Primary Data

Questionnaire methods have been used as a tool for a data collection in this research.

Secondary Data

Secondary data means data that are already available i.e., they refer to data which has already been collected and analysed by someone else. The secondary data for the study was collected from book, company websites, magazines and other sources. Sample size :50

5.5. Questionnaire Preparation

The basic requisite of any research study is the appropriate data which can be collected with the help of a schedule or questionnaire. With the help of questionnaire, it is easy to determine the involvement level of so many employees in the organization.

5.6. Pilot Survey

Before collecting the relevant data to test the hypothesis, it is essential to ascertain the applicability of the instrument to the population being studies. Hence, a pilot studies was undertaken with an objective to evaluate the tools prepared for the study and to find whether they are providing the information required.

5.7. Hypothesis Testing

H₀ – Null hypothesis (there is no significant relationship between the variables).

H_a – Alternative hypothesis (there is significant relationship between the variables).

After analysing the data, hypothesis testing is done. It will result in either accepting or rejecting the hypothesis.

5.8. Inference

After telling the hypothesis, the researcher comes out with his conclusion. The explanation of theory can also be considered as inference.

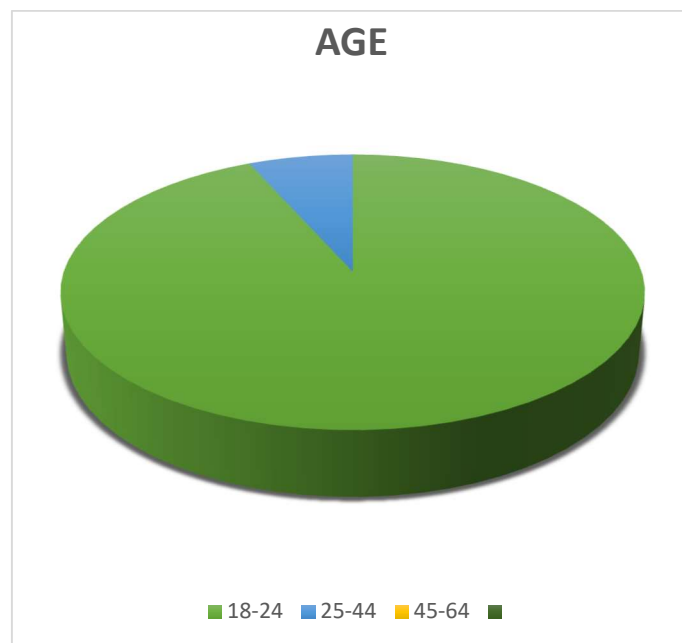
5.9. Preparation of Report and Presentation of Report

Finally, the researcher has to prepare a final report along with conclusion and suggestion.

DATA ANALYSIS AND INTERPRETATION

1.AGE OF THE RESPONDENTS

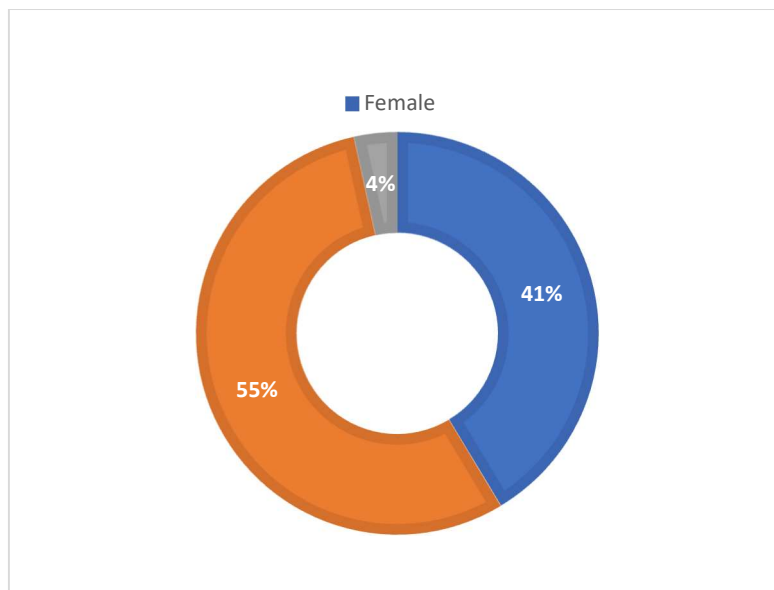
Particulars	No. of Respondent	Percentage of Respondent
18-24	28	96.55%
25-44	1	3.45%
45-64	0	0
Total	29	100



Inference: The age group 18-24 constitutes the majority of the responses, accounting for 93.33%.

2.GENDER OF THE RESPONDENTS

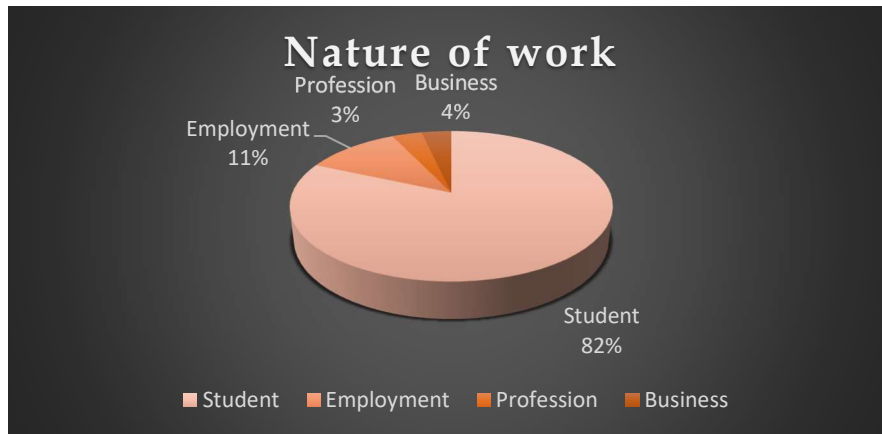
Particulars	No. of Respondent	Percentage of Respondent
Female	12	41.38%
Male	16	55.17%
Prefer not to say	1	3.45%
Total	29	100



Inference: Females represents the predominant segment of 55% among the respondents.

3.NATURE OF WORK OF THE RESPONDENTS

Particulars	No. of Respondent	Percentage of Respondent
Student	23	79.31%
Employment	4	10.94%
Profession	1	3.45%
Business	1	3.45%
Total	29	100

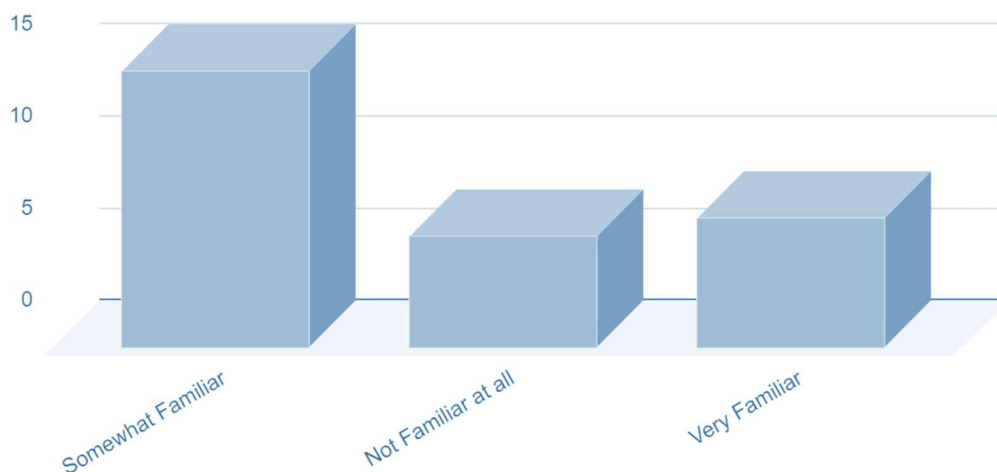


Inference: Majority of the responses constitutes among the Students Community-82%.

4.ANALYSIS OF FAMILIARITY WITH BLOCKCHAIN

Particulars	No. of Respondent	Percentage of Respondent
Very Familiar	7	24.14%
Somewhat Familiar	16	55.17%
Not Familiar at all	6	20.69%
Total	29	100

Familiarity with blockchain technology and its applications in supply chain management ?

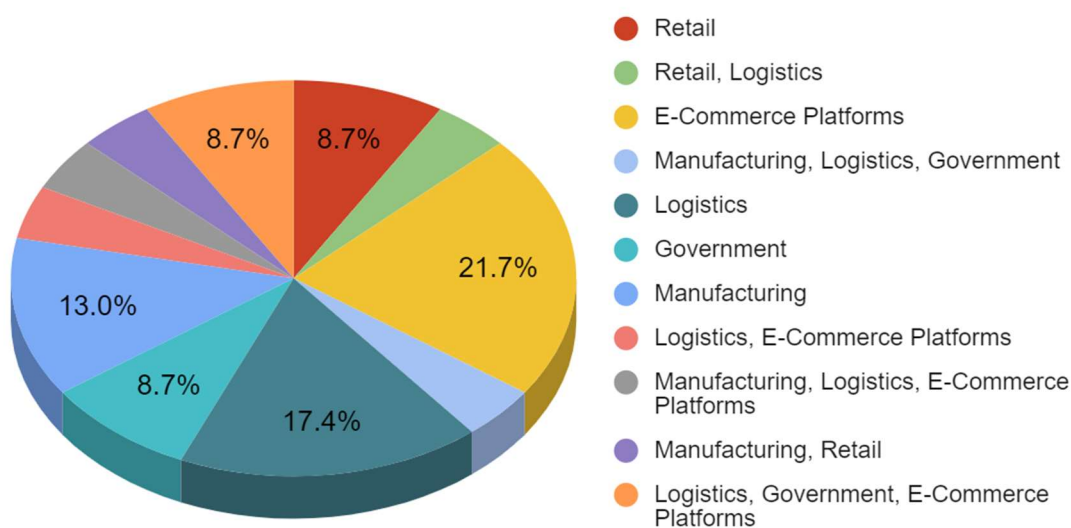


Inference: The above graph depicts that most of the Respondents are somewhat familiar about Blockchain and its applications in supply chain management.

5.ANALYSIS OF SUITABLE ORGANISATION FOR BLOCKCHAIN

Particulars	No. of Responses
Manufacturing	6
Retail	4
Logistics	11
Government	5
E-commerce Platforms	10
Total	36

Type of organisation that best suits with Blockchain Technology in their Supply chain Management ?

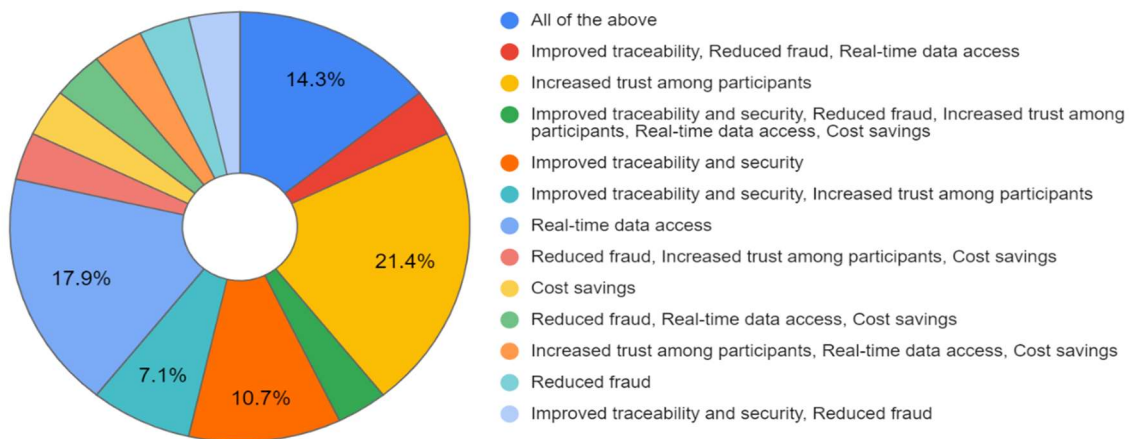


Inference: Most of the Respondents supports that Blockchain best suits with Ecommerce platforms and Logistics sector rather than any other sectors.

6.ANALYSIS OF BENEFIT OF BLOCKCHAIN

Particulars	No. of Responses
Improved Traceability	8
Reduced Fraud	7
Increased trust among participants	11
Real time data access	9
Cost savings	6
Improved Traceability and Security	4
Total	45

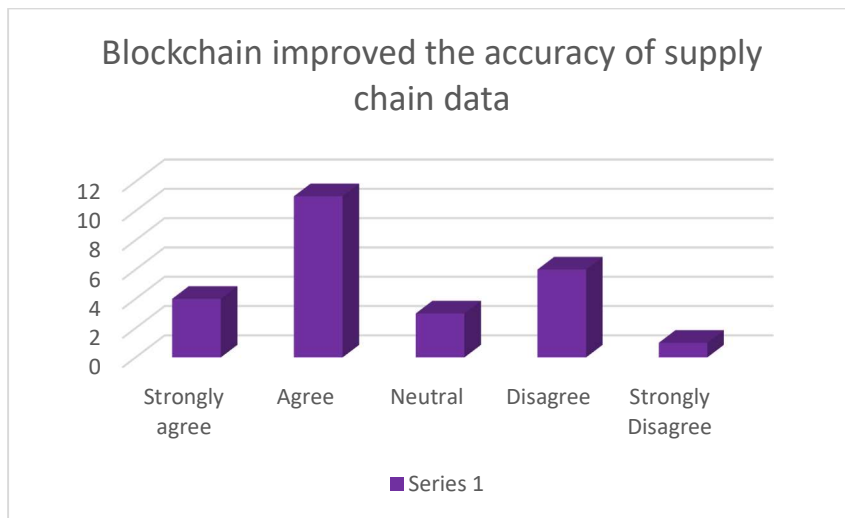
Benefit that blockchain brings to supply chain transparency



Inference: Increased trust among participants is considered as the most important benefit of Blockchain that brings supply chain transparency which constitutes 21.4% of the responses while others are negligible.

7.BAR CHART ANALYSIS -BLOCKCHAIN IMPROVES ACCURACY

Particulars	No. of Responses	Percentage
Strongly agree	4	16%
Agree	11	44%
Neutral	3	12%
Disagree	6	24%
Strongly Disagree	1	4%
Total	25	100

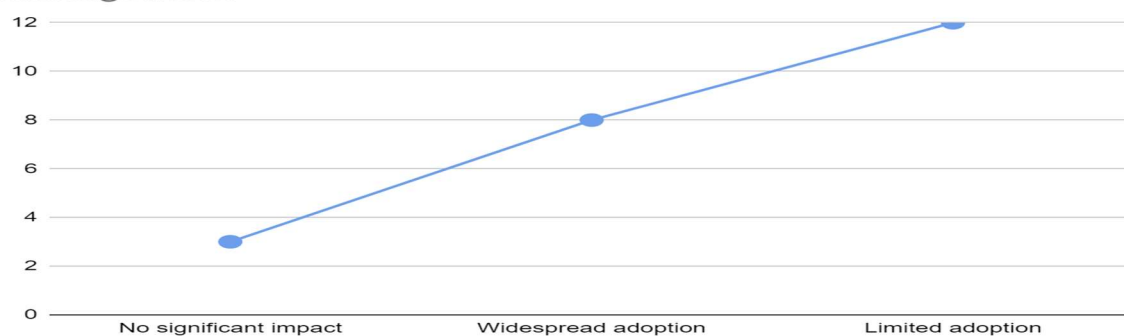


Inference: 44% of the respondents agreed that the blockchain has improved the accuracy of the supply chain data.

8.LINE GRAPH ANALYSIS - FUTURE OF BLOCKCHAIN

Particulars	No. of Respondent	Percentage of Respondent
Widespread adoption	9	37.5%
Limited adoption	12	50%
No significant impact	3	12.5%
Total	24	100

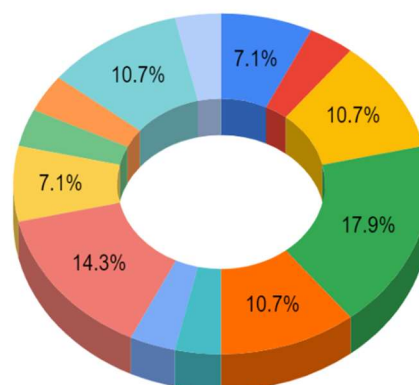
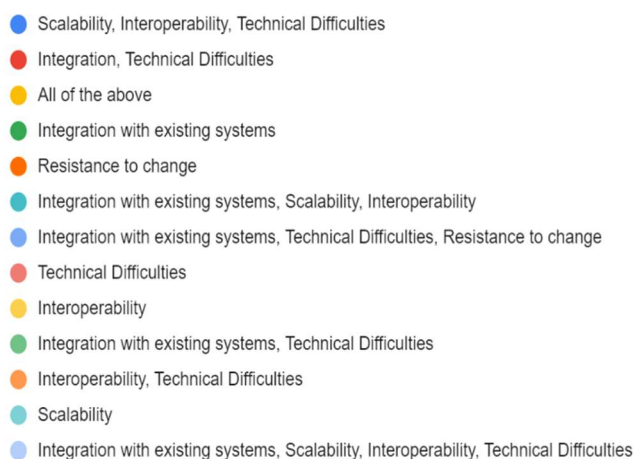
The future of blockchain technology in supply chain management



Inference: 50% of the Respondents foresee that the future of blockchain technology in supply chain management would have only Limited adoption.

9. PIE CHART ANALYSIS OF BARRIERS OF BLOCKCHAIN

Barriers encountered in implementing blockchain for supply chain transparency

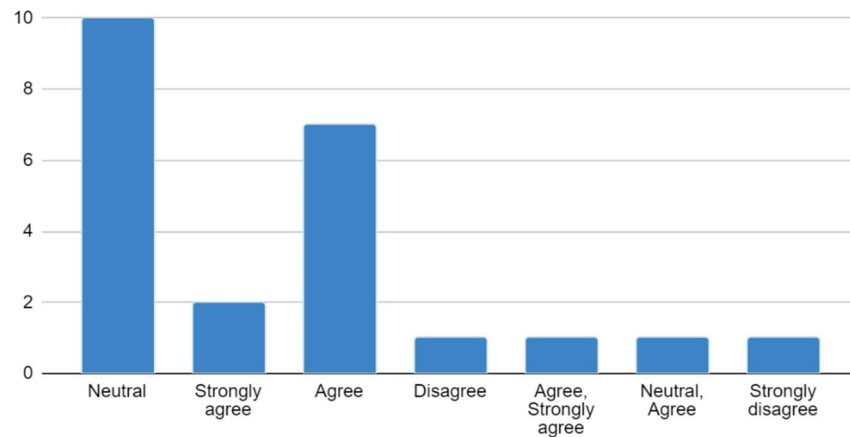


Inference: 17.9% of the responses shows that Integration of Blockchain with the existing systems is the major barrier in implementing the Blockchain for supply chain transparency.

10. BAR CHART ANALYSIS OF SUPPLY CHAIN FINANCE AS POTENTIAL FUTURE DEVELOPMENT

Particulars	No. of Responses	Percentage
Strongly agree	3	11.54%
Agree	9	34.62%
Neutral	11	42.31%
Disagree	1	3.84%
Strongly Disagree	2	7.69%
Total	26	100

Supply Chain Finance is the potential future development in blockchain's impact on supply chain transparency

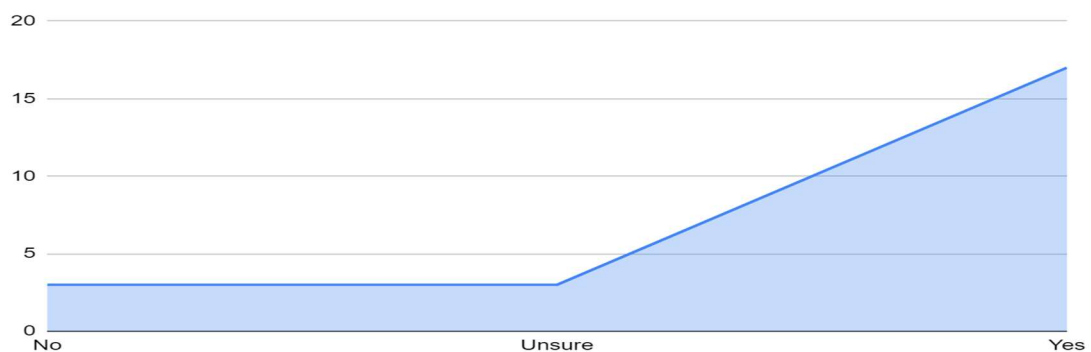


Inference: 42.31% of the Respondents believe that Supply chain Finance might be the potential future development in blockchain's impact in supply chain transparency but they did not agree strongly; only 11.54% agreed strongly.

11.LINE GRAPH ANALYSIS - BLOCKCHAIN WILL BECOME AN INDUSTRY STANDARD

Particulars	No. of Responses	Percentage
Yes	17	70.8%
No	3	12.5%
Unsure	4	16.7%
Total	24	100

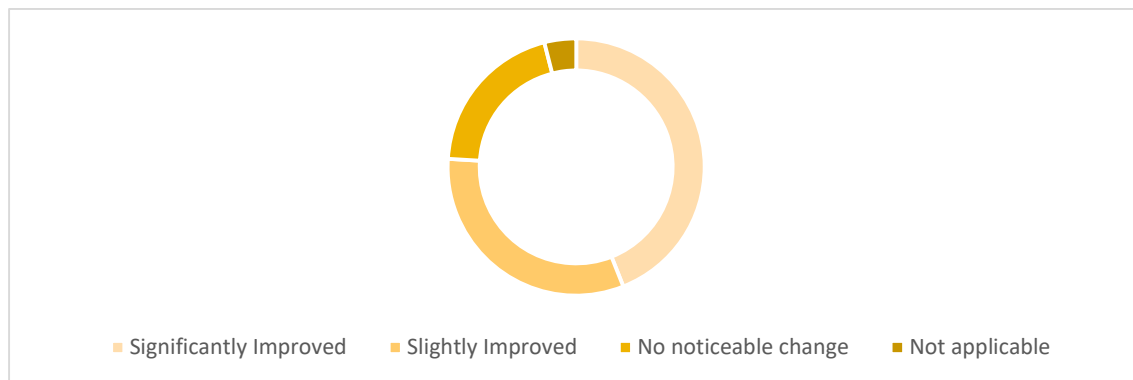
Will blockchain technology become an industry standard for supply chain management in the future



Inference: Majority of the Respondents (70.8%) believe that the Blockchain technology will become an industry standard for supply chain management in the future.

12.ANALYSIS OF IMPROVEMENT OF EFFICIENCY AND TRANPARENCY WHEN BLOCKCHAIN ADOPTED

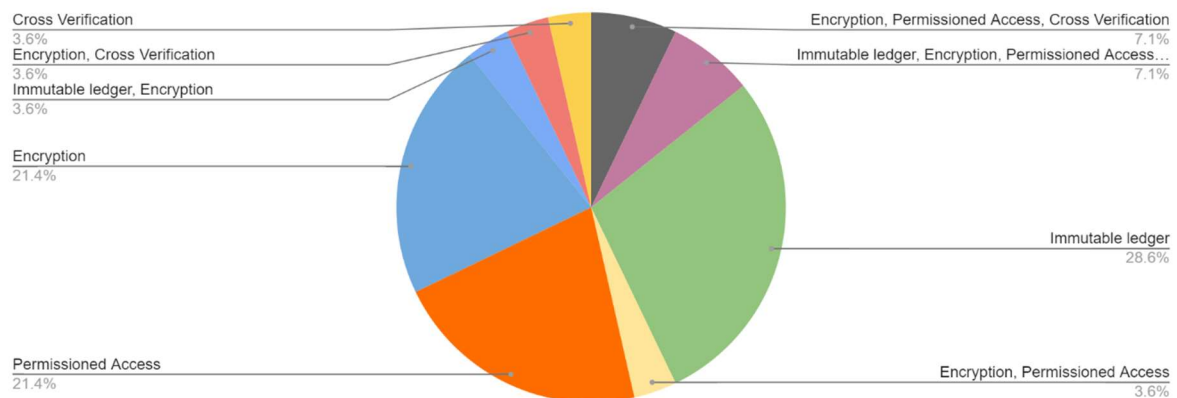
Particulars	No. of. Responses	Percentage
Significantly improved	11	45.8%
Slightly improved	8	33.3%
No noticeable change	5	20.8%
Not applicable	1	4.2%
Total	25	100



Inference: 45.8% of the Respondents says that the adoption of Blockchain would impact the Supply Chain Transparency and Efficiency.

13.PIE CHART ANALYSIS OF HOW BLOCKCHAIN ADDRESS SECURITY AND PRIVACY CONCERNS IN SUPPLY CHAIN

Blockchain addresses security and privacy concerns in the supply chain



Inference: 21.4% of the Respondents believe that the features of Encryption and Permissioned Access in Blockchain would addresses the security and privacy concerns in the supply chain.

CHI-SQUARE ANALYSIS

Chi-square analysis is a non-parametric statistical test used to determine the association between categorical variables. It assesses whether there is a significant difference between the observed and expected frequencies within one or more categorical variables.

PROBLEM: Examine the relationship between the degree of blockchain implementation in supply chains and the level of trust among supply chain participants

Null Hypothesis (H0):

"There is no significant relationship between the degree of blockchain implementation in supply chains and the level of trust among supply chain participants."

Alternative Hypothesis (H1):

"There is a significant relationship between the degree of blockchain implementation in supply chains and the level of trust among supply chain participants."

	Very Low	Low	Moderate	High	Very High	Total
Minimal Blockchain Usage	25	30	20	15	10	100
Low Blockchain Integration	20	25	15	10	5	75
Moderate Blockchain Adoption	30	35	25	20	15	125

High Blockchain Utilization	15	20	10	5	5	55
Comprehensive Blockchain Implementation	10	15	5	5	5	40
Total	100	125	75	55	40	395

The Row represents the extent of Blockchain implementation in Supply Chains (ranging from minimal usage to comprehensive implementation), while the columns represent the level of trust among supply chain participants (categorized as very low, low, moderate, high, and very high).

Step 1: Calculate expected frequency for each cell

$\text{Expected Frequency} = \frac{(\text{Row Total} * \text{Column Total})}{\text{Grand Total}}$

	Very Low	Low	Moderate	High	Very High	Total
Minimal Blockchain Usage	25.32	31.65	18.99	13.93	10.13	100
Low Blockchain Integration	18.99	23.74	14.24	10.44	7.60	75
Moderate Blockchain Adoption	31.65	39.56	23.74	17.41	12.66	125
High Blockchain Utilization	13.92	17.40	10.44	7.66	5.57	55

Comprehensive Blockchain Implementation	10.13	12.66	7.60	5.57	4.05	40
Total	100	125	75	55	40	395

Step 2: Compute the Chi-Square Statistic for each cell.

$\chi^2 = \frac{(O-E)^2}{E}$

Where O is the observed frequency and E is the expected frequency.

	Very Low	Low	Moderate	High	Very High
Minimal Blockchain Usage	0.00405	0.08601	0.05372	0.0822	0.00167
Low Blockchain Integration	0.05372	0.06688	0.04056	0.018544	0.889474
Moderate Blockchain Adoption	0.086019	0.525622	0.066874	0.385302	0.432512
High Blockchain Utilization	0.083793	0.388506	0.018544	0.923708	0.05833
Comprehensive Blockchain Implementation	0.001668	0.432512	0.889474	0.05833	0.22284

Step 3: Determine Degrees of Freedom (df)

$Df = (R-1) * (C-1)$

Where R= Number of rows in the table

C=Number of columns in the table

The given table representing the relationship between Blockchain implementation and trust levels, it is a 6*6 table (6 rows and 6 columns) including the row and column header.

$$Df = (6-1) * (6-1) = 5*5 = 25$$

Step 4: Find Critical Value and Interpret Results

The critical chi – square value depends on the chosen significance level (α) and the degrees of freedom (df), For $\alpha = 0.05$, we will find the critical chi – square value from a chi – square distribution table.

Since the df for the given contingency table is 25, the critical chi – square at $\alpha = 0.05$ is approximately 37.652.

Interpretation of Results

- If the calculated chi-square statistic (representing the relationship between blockchain implementation and trust levels) is greater than 37.652, we would have sufficient evidence to reject the null hypothesis at a significance level of 0.05. This suggests a significant relationship between the degree of blockchain implementation in supply chains and the level of trust among supply chain participants.
- If the calculated chi-square statistic is less than or equal to 37.652, we would not have enough evidence to reject the null hypothesis at a significance level of 0.05. This implies that there isn't enough statistical support to claim a significant relationship between blockchain implementation and trust levels based on the provided data.

In summary, the interpretation of the chi-square test result, concerning the chosen significance level and critical chi-square value, determines whether to accept or reject the idea of a significant association between blockchain implementation and trust levels in the supply chain.

ANOVA

ANOVA (Analysis of Variance), on the other hand, is a parametric statistical method employed to compare means across two or more groups to determine if there are statistically significant differences between the group means. It's particularly useful when analyzing the variations in continuous outcome variables concerning categorical predictor variables.

Problem:

A multinational company is exploring the impact of blockchain technology on the efficiency of supply chain operations across different departments. They want to analyze whether blockchain adoption influences the order processing time in three distinct departments: Procurement, Manufacturing, and Distribution.

The company collected data on the time taken for order processing (in hours) before and after implementing blockchain technology in each department. They want to determine if there's a significant difference in order processing times across the three departments due to the adoption of blockchain in the supply chain.

❖ Procurement Department:

Before Blockchain: [25, 28, 30, 26, 27]

After Blockchain: [20, 22, 21, 19, 18]

❖ Manufacturing Department:

Before Blockchain: [35, 32, 33, 30, 36]

After Blockchain: [28, 25, 26, 27, 29]

❖ Distribution Department:

Before Blockchain: [40, 42, 38, 39, 41]

After Blockchain: [36, 37, 35, 34, 33]

Step 1: Calculate the mean order processing times for each department before and after blockchain implementation.

Procurement Department:

- Before Blockchain: [25, 28, 30, 26, 27]

Mean before Blockchain = $(25 + 28 + 30 + 26 + 27) / 5 = 26.2$ hours

- After Blockchain: [20, 22, 21, 19, 18]

Mean after Blockchain = $(20 + 22 + 21 + 19 + 18) / 5 = 20$ hours

Manufacturing Department:

- Before Blockchain: [35, 32, 33, 30, 36]

Mean before Blockchain = $(35 + 32 + 33 + 30 + 36) / 5 = 33.2$ hours

- After Blockchain: [28, 25, 26, 27, 29]

Mean after Blockchain = $(28 + 25 + 26 + 27 + 29) / 5 = 27$ hours

Distribution Department:

- Before Blockchain: [40, 42, 38, 39, 41]

Mean before Blockchain = $(40 + 42 + 38 + 39 + 41) / 5 = 40$ hours

- After Blockchain: [36, 37, 35, 34, 33]

Mean after Blockchain = $(36 + 37 + 35 + 34 + 33) / 5 = 35$ hours

Step 2: Compute the sum of squares within groups (SSW) and sum of squares between groups (SSB).

SSW Calculation:

SSW Procurement (Before Blockchain):

$$SSW = (25 - 26.2)^2 + (28 - 26.2)^2 + (30 - 26.2)^2 + (26 - 26.2)^2 + (27 - 26.2)^2 = 5.2 + 1.2 + 10.8 + 0.04 + 0.8 = 18.04$$

SSW Procurement (After Blockchain):

$$SSW = (20 - 20)^2 + (22 - 20)^2 + (21 - 20)^2 + (19 - 20)^2 + (18 - 20)^2 = 0 + 4 + 1 + 1 + 4 = 10$$

SSW Manufacturing (Before Blockchain):

$$SSW = (35 - 33.2)^2 + (32 - 33.2)^2 + (33 - 33.2)^2 + (30 - 33.2)^2 + (36 - 33.2)^2 = 2.56 + 2.56 + 0.04 + 9.16 + 8.64 = 23.96$$

SSW Manufacturing (After Blockchain):

$$SSW = (28 - 27)^2 + (25 - 27)^2 + (26 - 27)^2 + (27 - 27)^2 + (29 - 27)^2 = 1 + 4 + 1 + 0 + 4 = 10$$

SSW Distribution (Before Blockchain):

$$SSW = (40 - 39.2)^2 + (42 - 39.2)^2 + (38 - 39.2)^2 + (39 - 39.2)^2 + (41 - 39.2)^2 = 0.64 + 7.84 + 2.56 + 0.04 + 2.44 = 13.52$$

SSW Distribution (After Blockchain):

$$SSW = (36 - 35)^2 + (37 - 35)^2 + (35 - 35)^2 + (34 - 35)^2 + (33 - 35)^2 = 1 + 4 + 0 + 1 + 4 = 10$$

SSB Calculation:

To calculate SSB, we need the grand mean:

Grand mean = (Sum of all observations) / (Total number of observations)

$$\text{Grand mean} = (25 + 28 + 30 + 26 + 27 + 20 + 22 + 21 + 19 + 18 + 35 + 32 + 33 + 30 + 36 + 28 + 25 + 26 + 27 + 29 + 40 + 42 + 38 + 39 + 41 + 36 + 37 + 35 + 34 + 33) / 30 = 30.83$$

$$SSB \text{ Procurement} = (5 * (26.2 - 29.73)^2) + (5 * (20 - 29.73)^2) = 695.86$$

$$SSB \text{ Manufacturing} = (5 * (33.2 - 29.73)^2) + (5 * (27 - 29.73)^2) = 101.76$$

$$SSB \text{ Distribution} = (5 * (40 - 29.73)^2) + (5 * (35 - 29.73)^2) = 508.4$$

Step 3: Calculate the degrees of freedom (df) for within groups and between groups.

$$dfw = \text{Total number of observations} - \text{Number of groups} = 30 - 3 = 27$$

$$dfb = \text{Number of group} - 1 = 3 - 1 = 2$$

Step 4: Compute the mean squares (MSW and MSB) by dividing the respective sums of squares by their degrees of freedom.

For within groups (MSW):

- MSW Procurement = SSW Procurement / dfw = $18.04 / 27 \approx 0.668$
- MSW Manufacturing = SSW Manufacturing / dfw = $23.96 / 27 \approx 0.888$
- MSW Distribution = SSW Distribution / dfw = $13.52 / 27 \approx 0.5$

For between groups (MSB):

- MSB Procurement = SSB Procurement / dfb = $695.86 / 2 \approx 347.93$
- MSB Manufacturing = SSB Manufacturing / dfb = $101.76 / 2 \approx 50.88$
- MSB Distribution = SSB Distribution / dfb = $508.4 / 2 \approx 254.2$

Step 5: Calculate the F-statistic using the formula $F = \text{MSB} / \text{MSW}$.

$F = \frac{\text{MSB}}{\text{MSW}}$

$F(\text{Procurement}) = 520.57$

$F(\text{Manufacturing}) = 57.27$

$F(\text{Distribution}) = 508.4$

Step 6: Determine the critical F-value based on the degrees of freedom and chosen significance level (e.g., 0.05) and

Compare the calculated F-value with the critical F-value to determine statistical significance.

Based on the comparison:

- If the calculated F-statistic is greater than the critical F-value, we reject the null hypothesis.
- If the calculated F-statistic is less than the critical F-value, we do not reject the null hypothesis.

CONCLUSION

Blockchain technology has emerged as a transformative force in enhancing supply chain transparency. Through its decentralized and immutable ledger system, blockchain has revolutionized the way data is recorded, verified, and shared across the supply chain network. The analysis conducted on the application of blockchain in supply chain transparency reveals several pivotal aspects.

Firstly, blockchain's inherent features, such as transparency, immutability, and decentralization, contribute significantly to addressing the challenges related to supply chain visibility. It enables real-time tracking of goods, tracing their origins, and verifying their authenticity, thereby fostering trust among stakeholders and mitigating issues like counterfeiting, fraud, and unethical practices.

Secondly, the integration of smart contracts within blockchain technology automates various processes, streamlines transactions, and ensures compliance with predefined conditions. This automation minimizes human errors, reduces paperwork, and facilitates the execution of transparent and secure agreements between parties involved in the supply chain.

Furthermore, the analysis underscores the potential of blockchain in creating a more sustainable and ethical supply chain ecosystem. By providing a comprehensive view of the entire supply chain, blockchain enables companies to identify inefficiencies, reduce waste, and enforce ethical sourcing practices, consequently promoting social responsibility and environmental sustainability.

However, despite its numerous advantages, the widespread adoption of blockchain technology in the supply chain sector faces certain challenges. Issues like scalability, interoperability among different blockchain

platforms, regulatory concerns, and the need for industry-wide standardization remain significant hurdles that need to be addressed for broader implementation.

The application of blockchain in supply chain transparency presents an array of compelling advantages that promise to redefine the way industries operate. Its ability to offer enhanced traceability, bolster consumer confidence, optimize supply chain processes, ensure ethical compliance, and reduce disputes and fraud stands as a testament to its transformative potential.

Moreover, blockchain's capacity to foster global collaboration, minimize intermediaries, aid in regulatory compliance, and pave the way for a more sustainable and efficient supply chain ecosystem cannot be overstated.

While challenges persist in terms of scalability, interoperability, and regulatory concerns, the overarching benefits of blockchain technology in driving transparency and accountability across supply chains cannot be ignored. Overcoming these challenges will undoubtedly lead to a future where blockchain-powered transparency becomes the cornerstone of a more trusted, efficient, and sustainable global supply chain landscape.

In conclusion, the analysis illustrates the remarkable potential of blockchain technology to revolutionize supply chain transparency. Its ability to provide an immutable and transparent record of transactions, coupled with smart contract functionalities, offers a promising framework for enhancing trust, efficiency, and accountability across supply chains. Overcoming existing challenges will be crucial in harnessing the full capabilities of blockchain, paving the way for a more transparent, efficient, and sustainable future for global supply chains.

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ANNEXURE - QUESTIONNAIRE

Name: -----

1. Age:

- ☐ 18-24
- ☐ 25-44
- ☐ 45-64

2. Gender:

- ☐ Female
- ☐ Male
- ☐ Prefer not to say

3. Nature of work

- ☐ Student
- ☐ Employment
- ☐ Profession
- ☐ Business

4. How familiar are you with Blockchain Technology and its applications in supply chain management?

- ☐ Very Familiar
- ☐ Somewhat Familiar
- ☐ Not Familiar at all

5. Which type of organization best suits with Blockchain Technology in their supply chain management?

- ☐ Manufacturing
- ☐ Retail
- ☐ Logistics
- ☐ Government
- ☐ E-commerce Platforms
- ☐ Other

6. What benefits do you believe Blockchain brings to supply chain transparency?
 - Improved traceability and security
 - Reduced Fraud
 - Increased trust among participants
 - Real time data access
 - Cost savings
7. What challenges or barriers have you encountered in implementing Blockchain for supply chain transparency?
 - Integration with existing systems
 - Scalability
 - Interoperability
 - Technical Difficulties
 - Resistance to change
8. Has Blockchain improved the accuracy of supply chain data?
 - Strongly agree
 - Agree
 - Strongly disagree
 - Disagree
 - Neutral
9. How do you foresee the future of Blockchain Technology in supply chain management?
 - Widespread Adoption
 - Limited Adoption
 - No significant impact
10. How has the adoption of Blockchain would impact the supply chain transparency and efficiency?
 - Significantly improved
 - Slightly improved
 - No noticeable change
 - Not applicable

11.How does Blockchain address security and privacy concerns in supply chain?

- Immutable ledger
- Encryption
- Permissioned Access
- Cross Verification

12.In your opinion, Supply Chain Finance is the potential future development in Blockchain's impact on supply chain transparency.

- Strongly agree
- Agree
- Strongly disagree
- Disagree
- Neutral

13.How has Blockchain influenced collaboration with suppliers, manufacturers, and other stakeholders?

- Transparency
- Smart Contracts
- Cross Border Transactions
- Decentralization
- Data Integrity

14.Do you believe that Blockchain Technology will become an industry standard for supply chain management in the future?

- Yes
- No
- Unsure

15.Do you have any other suggestions on impact of Blockchain Technology on Supply chain Transparency?
