

Czech University of Life Sciences Prague

Faculty of Economics and Management

Department of Information Technologies



Master's Thesis

**Integrating the Blockchain with Supply Chain
Management**

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CZECH UNIVERSITY OF LIFE SCIENCES PRAGUE

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Economics Policy and Administration
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Thesis title

Integrating the Blockchain into Supply Chain Management

Objectives of thesis

The thesis explores the scope of integrating Blockchain into Supply Chain Management. The main objective is to determine whether blockchain can help with the optimization of the supply chain in enterprises by enabling better traceability, transparency and trust.

Partial goals of the thesis also include:

- To analyze current uses of blockchain within enterprises;
- To identify potential opportunities and limitations of using blockchain within enterprises with a special focus on supply chain management;
- To conduct surveys among decision-makers in selected companies in order to analyze the impact of implications of integrating blockchain into supply chain management;
- To interpret results and formulate recommendations;

Methodology

The methodology of the thesis is based on two parts: theoretical and practical. The theoretical part will be made of an extensive literature review on the said topic. The practical part will be accomplished by conducting interviews/surveys with decision-makers in predefined business fields and geographical locations such as Europe and India. Based on the synthesis of theoretical knowledge, results of surveys/interviews and own research conclusion will be formulated.

The proposed extent of the thesis

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Declaration

I declare that I have worked on my master's thesis titled "Integrating Blockchain with Supply Chain" by myself and I have used only the sources mentioned at the end of the thesis. As the author of the master's thesis, I declare that the thesis does not break any copyrights.

In Prague on 29.11.2021

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Integrating the blockchain with supply chain management

Abstract

Chains supplying modern goods face a variety of challenges that put pressure on long-term performance. Advances in technology can address many of these problems. Blockchain is seen as one of the technologies that could play a major role in the future supply chain. In this thesis, the main objective was to provide a clear view of the potential impact of blockchain technology on long-term supply chain operations. In addition, it should help one establish a basic understanding of blockchain technology and distinguish between the non-blockchain supply chain and the supply chain using blockchain-based solutions. A comprehensive book review contains the required background information on the basics of blockchain technology, supply chain management in modern times, and blockchain applications in supply chains. Following this, 20 interviews were conducted to support the findings and to evaluate the effects of blockchain deployments on supply chains. Highly efficient processes, low cost, and fast transactions were often cited as major potential operational improvements, while the amount of power required by the blockchain was a major factor that could undermine supply chain performance. Following the written record, a model was developed that provided a broader perspective on the potential impact identified in supply chain operations.

Keywords: Blockchain, Opportunities, Limitations, Supply Chain Management, Traceability, Optimization, Transparency, Ecosystems.

Integrace blockchainu se správou dodavatelského řetězce

Abstrakt

Řetězce dodávající moderní zboží čelí řadě výzev, které vytvářejí tlak na dlouhodobou výkonnost. Pokroky v technologii mohou mnohé z těchto problémů vyřešit. Blockchain je považován za jednu z technologií, které by mohly hrát hlavní roli v budoucím dodavatelském řetězci. V této práci bylo hlavním cílem poskytnout jasný pohled na potenciální dopad technologie blockchain na dlouhodobé operace dodavatelského řetězce. Kromě toho by to mělo pomoci vytvořit základní porozumění blockchainové technologii a rozlišit mezi non-blockchainovým dodavatelským řetězcem a dodavatelským řetězcem využívajícím řešení založená na blockchainu. Komplexní recenze knihy obsahuje požadované základní informace o základech blockchainové technologie, řízení dodavatelského řetězce v moderní době a blockchainových aplikacích v dodavatelských řetězcích. V návaznosti na to bylo provedeno 20 rozhovorů s cílem podpořit zjištění a vyhodnotit dopady nasazení blockchainu na dodavatelské řetězce. Vysoce efektivní procesy, nízké náklady a rychlé transakce byly často uváděny jako hlavní potenciální provozní zlepšení, zatímco množství energie požadované blockchainem bylo hlavním faktorem, který mohl podkopat výkon dodavatelského řetězce. Na základě písemného záznamu byl vyvinut model, který poskytl širší pohled na potenciální dopad identifikovaný v operacích dodavatelského řetězce.

Klíčová slova: Blockchain, příležitosti, omezení, řízení dodavatelského řetězce, sledovatelnost, optimalizace, transparentnost, ekosystémy.

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List of abbreviations

AI = Artificial Intelligence

CBSCA = Canadian Blockchain Supply Chain Association

CSR = Corporate Social Responsibility

ID = Identification

IoT = Internet of Things

IP = Intellectual Property

IT = Information Technology

QR code = Quick Response Code

RFID = Radio Frequency Identification

ROI = Return on Investment

SC = Supply Chain

SCM = Supply Chain Management

SME = Small and Medium-sized Enterprise

SSC = Sustainable Supply Chain

SSCM = Sustainable Supply Chain Management

1 Introduction

"Data is the new oil" – nowadays, smart IoT devices in almost every industrial and private application are producing massive amounts of data. This, on the one hand, opens possibilities for various uses like just in time production, custom-tailored marketing campaigns and detailed analytics of the enterprise itself. In Business Intelligence (BI), vast amounts of data are stored in so-called data warehouses, mainly on the entity's local servers. However, a new approach to automatically and decentralized storing this data could be using a blockchain.

The potential of blockchain has been extensively discussed in the literature and media, mainly in the finance and payment industry. One relatively recent trend is at the enterprise level, where blockchain serves as the infrastructure for internet security and immutability. This master thesis could highlight the "new" possibilities that the blockchain could generate for an enterprise in data storage and efficiency. Further, the thesis could highlight current uses of the blockchain within enterprises and point out limitations and possible solutions. This can be done by an extensive literature review on this topic and/or by interviews conducted with decision-makers in predefined business fields and geographical locations. The thesis's goal is to determine whether the blockchain helps enterprises be more efficient for future applications and whether the blockchain can help increase the process of decision-making within the firm.

2 Objectives and Methodology

2.1 Objectives

The thesis explores the scope of integrating Blockchain into Supply Chain Management. The main objective is to determine whether blockchain can help with the optimization of the supply chain in enterprises by enabling better traceability, transparency, and trust.

Partial goals of the thesis also include:

- To analyse current uses of blockchain within enterprises.
- To identify potential opportunities and limitations of using blockchain within enterprises with a special focus on supply chain management.
- To conduct surveys among decision-makers in selected companies in order to analyse the impact of implications of integrating blockchain into supply chain management.
- To interpret results and formulate recommendations

2.2 Methodology

Methodology for the literature review is based on data collection from specialized publications, websites, journals and other written or online sources. The master thesis mainly consists of two parts: theoretical and practical.

The theoretical part is based on literature review that provides understanding about blockchain technology. The practical part is about utilizing the learned topics and implementing it in a best possible manner. The practical part includes analysis of challenges faced by enterprises in implementing blockchain technology. The analysis provides information about the opportunities and limitations of using blockchain within enterprises.

The method of analysis and synthesis is used to formulate the conclusion for thesis. The overview about introduction of blockchain technology, principles of blockchain technology and applications of blockchain technology is included in literary review of this thesis.

3 Literature Review

3.1 Introduction to Blockchain

The 21st century is about technology. With the growing modern need in our daily lives, people are open to adopting new technologies. From using remote control devices to use voice notes to give commands; modern technology has opened a space in our ordinary lives. Technologies like the unpopular reality of taxpayers we see and IoT have gained momentum over the past decade and now a new addition to the package is Blockchain Technology (Mayank Pratap, 2018).

Blockchain is a revolutionary technology which affects various industries, and it is significantly introduced to the market through its modern system called Bitcoin. Bitcoin is nothing but a form of digital currency (cryptocurrency) that can be used in place of fiat trading currency. And the key to success in cryptocurrencies is called Blockchain (Mayank Pratap, 2018).

There is a common misconception among people that Bitcoin and Blockchain are one and the same, however, this is not the case. Making cryptocurrencies is one of the applications of Blockchain technology and apart from Bitcoin, there are many applications made on the basis of blockchain technology.

Blockchain is the backbone of Digital Cryptocurrency Bitcoin Technology. A blockchain is a distributed database of records of all transactions or digital events that are shared between participating groups. Each activity is verified by most program participants. Contains all records of each transaction. Bitcoin is a popular cryptocurrency that is a blockchain model. Blockchain Technology first appeared when an individual or group of people named 'Satoshi Nakamoto' published a white paper on "Bitcoin: Peer to peer electronic system cash" in 2008. The Blockchain Technology Records Transaction in Digital Ledger distributed on the Network thus makes it more secure. Anything with value such as real estate, cars, etc. It can be recorded on the blockchain as a transaction (S. Nakamoto ,2008).

3.2 Blockchain in the developing world

Our world is improving every day and especially in the last 40 years. The first paradigm is the mainframe paradigm, the second is the PC (personal computer), and after that the Internet changed everything. The third was mobile sites, and these days Blockchain technology could be a new paradise emerging. It is possible useful in the world of computers as economic overlay. Internet Sensors — for devices, smartphones, laptops, smart home, smart car, smart city and newer can be developed with blockchain. This blockchain economy is moving funding, information transfer and effective resource allocation that is powered by money on the scale

of human and business the economy. (Swan, 2015, 11-12). Due to the global spread of the internet and cellular communication, blockchain technology can be distributed more quickly than any of the previous paradigms (Crosby et al., 2016, 8).

Social and mobile services such as Paradigm 4 became one of the largest the social component and all mobile applications of any businesses. The same changes are blockchain as Paradigm 5 can bring with it. It is possible bring the ability to work with value exchange. “The operation of Paradigm 5 could be normal connected, seamless, physical world, multi-computer layer, with blockchain technology that is covered by payments as the Web has never had.” (Swan, 2015, 11).

3.3 Blockchain definition

In simple terms, Blockchain can be defined as a data structure that holds transaction records and while ensuring security, transparency, and distribution of people in shared areas. You can also think of it as a chain or records kept in the form of blocks controlled by a single authority. A blockchain is a distributed platform that is completely open to anyone and anyone on the network. Once the information is stored in the blockchain, it is very difficult to modify or modify it.

Each transaction in the blockchain is protected by a digital signature that verifies its authenticity. Due to the use of encryption and digital signatures, the data stored in the blockchain has evidence of interference and cannot be altered.

Blockchain technology allows all network participants to reach an agreement, commonly known as an agreement. All information stored on the blockchain is digitally recorded and has the same history available to all network participants. In this way, the chances of any fraudulent activity or repetition of transactions are eliminated without the need for a third party.

As a topic of increasing importance in the field of promising technology, blockchain technology requires a proper definition for better understanding. Although it is a popular topic, these days, no standard definition is acceptable, including all its relevant features. In an effort to integrate all the significant features, Swan (2015) cites it as the basis for a new economy, justified by the presence of a transparent, open and low database. Further interpretation from Bradley (2016) defines it as open-source technology, acting as one of the current systems in one place, because the coordinator, as a third partner, has been skipped due to integrated validation within the planned environmental system. Another Drescher (2017) defines it as a peer-to-peer (P2P) journal program, which uses an algorithm, software-based components to provide information to integrated data blocks with the help of cryptographic security technology. Some scholars such as Klötzner & Iten (2019) see the blockchain as an unalterable transaction list in a distributed network where participant entries are verified with a digital signature and integrated sequentially following the compliance process.

Twesige (2015) compares it to the Internet by calling blockchain a code of conduct that governs the rules and regulations of exchange rates within a particular network, while the Internet serves as a means of exchange communication. The value here is generally defined as a measure of interest to an economic agent. The reduction in the three bases marks Kuner et al. (2018), which created a blockchain as a system for recording a series of encrypted data objects to make it as difficult as possible to intercept the entries and there is a democratically agreed procedure to keep copies of the journal.

A controversial approach to blockchain interpretation comes from Pilkington (2017), which mentions Vitalik Buterin, developer of the blockchain computer platform Ethereum. He says the definition of a blockchain does not link to any of the technical features and attributes as mentioned above. You see algorithms, compatibility and cryptography are more like applications and structures than definitions. Blockchain here explains the visible effects of actions taken by network users. Therefore, as a temporary and evolutionary technology developed by the network.

Thanks to technologies that are ubiquitous around the world, many scholars use the word blockchain unequally. However, there are many words and phrases used, associated with it. According to Dascano (2018), like an accounting magazine, the term blockchain defines a spreadsheet. This spreadsheet contains all the activity done between users on the network. The process uses blocks and each of these blocks contains details of everything that happened and is linked to the previous block. The process of tying these blocks together with a chain led to a blockchain era.

In addition, back et al. (2014) note that there is also the possibility of the use of so-called sidechains, which are similar to a key chain that creates opportunities to reduce information delays in exchange for a number of assurances to achieve consensus while the principle of trust is consistently held. Moreover, with pegged side chains, the transfer of assets between multiple blockchains seems likely to occur soon. In addition, Laurence (2017) states that the size, time and event that triggers new blocks are different across all blockchains as not all blockchains see velocity, transparency, mobility or safety record as similar goals. Depending on the purpose of creating the value, the shift attention to one of the targets. The act of tying up different blocks together occurs mathematically in the process of building trust.

3.4 Overview of Use of blockchain

To better understand blockchain, consider an example where a person wants the option to send money to a friend who lives elsewhere. A common option that a person can usually use would be a bank or a payment transfer system such as PayPal or Paytm. This option includes third parties so that they can process the transaction because it deducts an additional amount of his money as a transfer fee. Moreover, in cases like

these, a person cannot guarantee the safety of his own money as it is very likely that a criminal could hack into the network and steal his money. In both cases, the customer is poor. That's where Blockchain comes in.

Instead of using a bank to transfer money, if people use a blockchain in such cases, the process becomes much easier and more secure. No additional fees are involved as the funds are processed by an individual thus, eliminating the need for a third party. In addition, the blockchain database is still distributed and is not limited to any single location which means that all information and records stored in the blockchain are public and enabled. Since the data is not stored in one place, there is no chance of data corruption by any attacker.

3.5 Principles of blockchain

A blockchain is a series of blocks containing data or details. Despite previous findings, the first successful and popular use of Blockchain technology was in 2009 by Satoshi Nakamoto. He created the first digital currency called Bitcoin using Blockchain technology. Let's understand how the blockchain works.

Each block in the blockchain network stores specific information and the hash of the previous block. A hash is a unique mathematical code belonging to a particular block. If the details within the block are changed, the block hash will also be subject to modification. Connecting blocks using different hash keys is what makes the blockchain safe.

While the transaction takes place in the blockchain, there are nodes in the network that verify this transaction. In the Bitcoin blockchain, these nodes are referred to as miners and use the concept of proof of performance to be able to process and validate transactions on the network. For a transaction to work, each block must refer to the previous block hash. Transactions will only take place and only if the hash is correct. If a criminal try to attack the network and change the details of any particular block, the hash attached to the block will also be fixed.

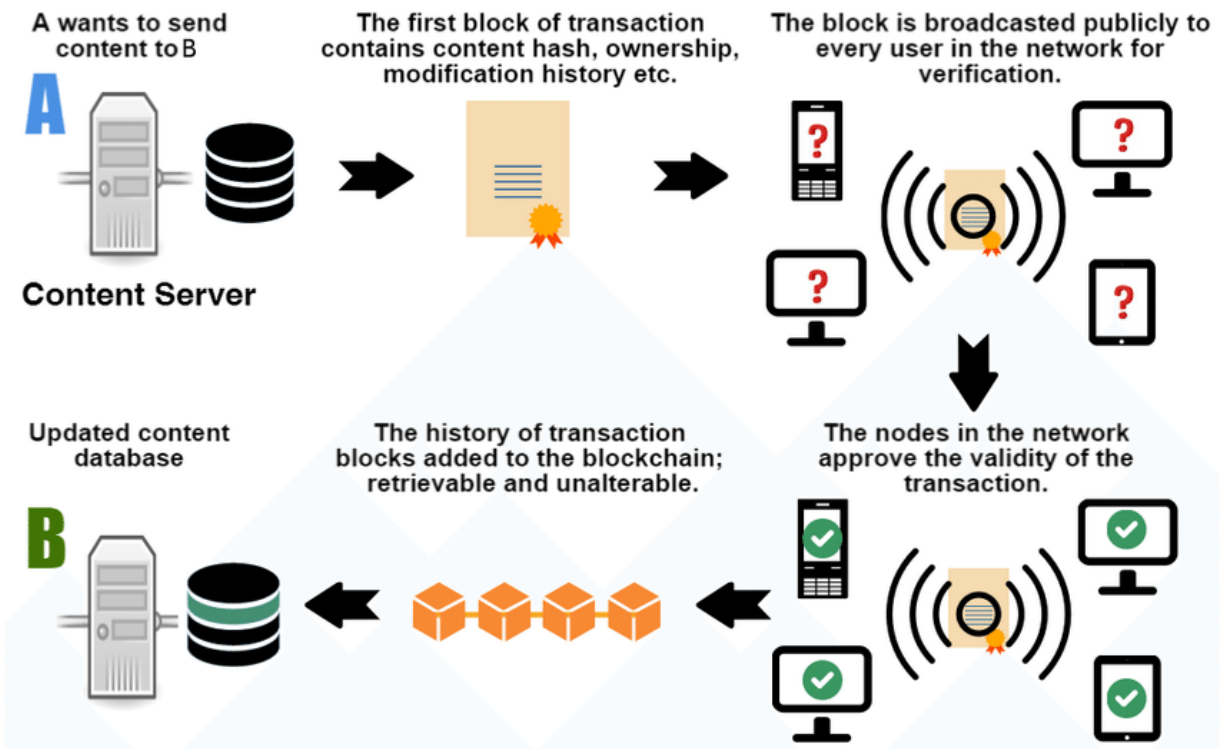


Figure 2: The working of blockchain (Source: Bhowik, Deepayan & feng, Tian, 2017)

Violations will be found as the correct hash will not be the same as the original. This ensures that the blockchain cannot be changed as if any changes made to the blockchain will be visible across the network and will be easily accessible.

Briefly, here is how the blockchain allows transactions to take place:

- The blockchain network uses public and private keys to create a digital signature that guarantees security and consent.
- Once verification is confirmed with these buttons, the need for authorization arises.
- Blockchain allows network participants to perform statistical verification and reach agreement on any value.
- During the transfer, the sender uses his or her secret key and announces the transaction details over the network. A block created contains information such as a digital signature, a timestamp, and the recipient public key.
- This information block is transmitted over the network and the verification process begins.
- Miners across the network began solving a work-related mathematical puzzle to consider. Solving this puzzle requires miners to invest in computer power.
- When he solves the puzzle first, the miner earns rewards in the form of bitcoins. Such problems are called job statistics problems.
- When most of the nodes in a network reach an agreement and agree to the same solution, a block is a time stamped and added to an existing blockchain. This block can contain anything from money to data to messages.

- After a new block is added to the chain, existing copies of the blockchain are updated to all nodes in the network.

Casey & Vigna (2018) argued that during the last financial crisis, caused by financial fraud and accounting fraud, when the level of trust was alarmingly low, people began to put faith in the system, which provided transparency, speed, and security during data exchange. However, according to Burnett & Paine (2011), several puzzles, however, paint a blockchain image, in which it is said and made public some time ago. With the advent of the RSA cryptosystem in 1977, the use of secure data transfers was aided by the random allocation of random numbers and letters, which served as random keys created by the algorithm. Alam (2019) points out that at the beginning of the nineties of the last century, scientists Haber and Stornetta expressed his first impression of the creation of a text-driven, timeless and digital text without going backwards. Unfortunately, the use of the patent ended when it was not used in 2004. Finally, Nian & Chuen (2015) notes that the next step refers to the introduction of the so-called reusable evidence of work. This method shows a scheme that allows for the use and exchange of tokens, representing a certain amount of assets.

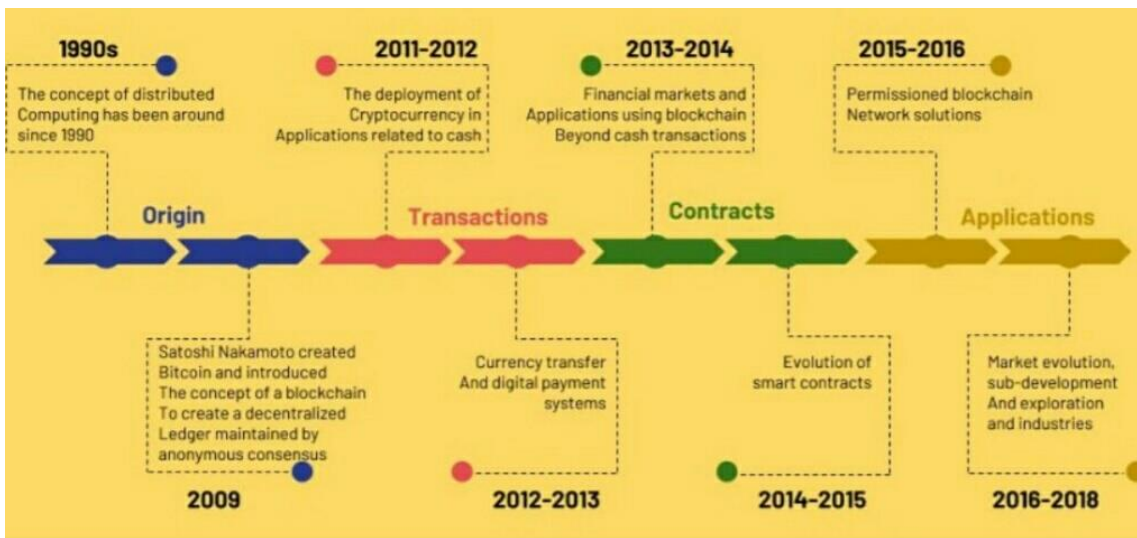


Figure 3: The performance of blockchain technology

Figure 3 shows the performance of blockchain technology in terms of its application areas. New developments are aimed at the application area, particularly the synchronized network solutions that are not licensed and tested among the industries submitted. It means that markets can be open to the development and implementation of common uses in the future, especially on mobile and mobile devices.

There are many ways to achieve consistency in a shared network. The most widespread method of witnessing (PoW). Here the foundation of technology is built on cryptography. Schneier (1996) defines cryptography as a science, related to the protection of messages, in which data is entered to encrypt what is called

ciphertext, representing the encrypted content. Clear encryption is required if the actual data is visible again. The whole integration process involves two mathematical operations, representing a computer rule called a cryptographic algorithm. To make data transfer possible, Zheng et al. (2018) state that digital signatures are unavoidable, meaning that each transaction participant has two keys, namely a private key and a public key. The public key is defined as the address, which is visible to the network, and the private key represents personal information, opening the way for the recipient of the transaction.

While the recipient public key is first used by the sender in the so-called encryption signature, then we see in the confirmation section the recipient's private key used to verify what is done by comparing the received and encrypted data. Mohanty (2018) argues in context with PoW that so-called miners, who provide computer power and solve math problems, ensure transactions within the blockchain. Once a miner finds the right numerical solution, the network becomes aware of and distributes rewards to participating miners in accordance with the blockchain protocol. All blocks must provide proof of performance to obtain valid recognition.

Changes in data structure in encryption and encryption process explain Paar & Pelzl (2010) by showing how the hash functions work. Transaction messages are faster, which means they are converted into smaller strands. It makes hash represent transaction data and unique fingerprint of transaction content. The whole signing and verification process only has hash values, which input lengths can be random while output lengths are independent and have a limited digital length. This ensures fast processing of the most important data values to avoid latency times. The definition that hashes is an important part of blockchain design shows Nguyen & Kyungbaek (2018) in describing the features of the blockchain. All information within the block is entered into a hash function to find the value, which will provide a field called previous hash to the new block.

This measure ensures that the blocks are seamlessly connected to each other, including a timestamp indicating the time at which the block was found and completed. In this regard, it is important to note that not all blockchains are equally fast. A suitable definition provides Antonopoulos (2016), which indicates that the measure of how difficult it is to obtain a hash is called difficulty. A comprehensive network setting that controls how much computer power is needed to generate PoW is needed to avoid any major instability and instability in the network. The setting is kept in the block as a weight metric, which is a powerful parameter, and can be changed in such a way that the block generating scheme lasts longer. Rosenberger (2018) calls the mining process a trial-and-error process and adopts various types of hash algorithms (SHA) that are protected from a host of trees called Merkle-tree, which combine in pairs up to the size of a block. Although

the PoW reward-based program seems to benefit all stakeholders, it is doubtful how sustainable energy is to be allocated to power at the highest level of power consumption.

3.6 Features of Blockchain

The features of revolutionary technology blockchain are as follows:

Decentralized

Blockchains are geographically categorized which means that no one person or group controls the entire network. While everyone in the network has a copy of the ledger distributed with them, no one can change it on their own. This unique blockchain feature allows for clarity and security while empowering users.

Peer-to-Peer Network

With the use of Blockchain, communication between two groups through a peer model is easily achieved without the need for any third party. Blockchain implements a P2P protocol that allows all network participants to hold a single copy of a transaction, which allows for consistent machine acceptance. For example, if you wish to make any transaction from one part of the world to another, you can do so via blockchain alone in a matter of seconds. In addition, any interruptions or additional costs will not be deducted from the transfer.

Immutable

A fixed blockchain asset refers to the fact that any data that has ever been written in a blockchain cannot be changed. To understand consistency, consider sending an email as an example. Once you've sent an email to a lot of people, you can't take it back. To get around, you'll need to ask all recipients to delete your annoying email. This is a consistent approach to work.

Once the data is processed, it cannot be modified or altered. In the case of a blockchain, if you are trying to change data for one block, you will have to change the rest of the blockchain you are following as each block retains the hash of the previous block. A single hash switch will result in a change for all subsequent hashes. It is extremely complicated for a person to change all hashes because it requires a lot of calculation power to do so. Therefore, the data stored in the blockchain will not be affected by hacker or hacker attacks due to inconsistencies.

Tamper-Proof

With the fixed assets embedded in the blockchains, it is easy to detect interference of any data. Blockchains are considered offensive evidence as any change in a single block can be detected and addressed effectively. There are two main ways to detect interference, namely hashes and blocks.

As mentioned earlier, each hash function associated with a block is different. You can view it as a block fingerprint. Any change in the data will result in a hash function version. Since the hash function of one block is linked to the next block, for the criminal to make any changes, he will have to change the hashes of all the blocks behind that block which is difficult to do

3.7 Types of Blockchains

Although Blockchain has evolved on many levels since its inception, there are two broad categories in which blockchains can be categorized primarily namely Public and Private blockchains.

Zheng et al. (2018) cite significant differences in defining blockchain enrolment in the public and private blockchain. Depending on the division of one of the two, existing application fields can be determined. It depends on the type of application case that can be used in any blockchain. The public blockchain is defined by the open access to verification areas of the contract-building process, so all transactions are visible to the public. The large number of participants acting as a consortium on the social network confirms that lying is almost impossible but costs high levels of delays and efficiency.

In addition, social blockchains identify them as robust networks. On the other hand, Lin & Liao, (2017) points out that independent blockchains have strict control over access to data, paired with a limit on the decision of who can participate in the network. This type of authority management leads to the fact that these blockchains are entirely owned by an organization that can determine the method of consent, access permission or possible modification or modification of a document. The books also offer a mixed alternative, such as the consortium blockchain, which features both public and private information.

Before we understand the differences between the two, let's look at the similarities of both the public and private blockchain:

- Both the Public and Private Blockchain have close peer-to-peer networks.
- All network participants maintain a copy of the shared ledger.
- The network keeps backup copies and syncs the latest updates with the help of syncing.
- The rules of consistency and security of the ladder are determined and applied to the network to avoid malicious attacks.

Now that we know the similarities between the two blockchains, let's learn a little more about each of them.

3.7.1 Public Blockchain

As the name suggests, a public blockchain is an unauthorized book and can be accessed by anyone or anyone. Anyone with internet access is welcome to download and access. In addition, one can also check the overall history of the blockchain and make any transaction with it. Social blockchains often reward network participants by performing a mining process and maintaining a level of flexibility. An example of a public blockchain is the Bitcoin Blockchain.

Social blockchains allow communities around the world to exchange information freely and securely. However, the obvious disadvantage of this type of blockchain is that it can be compromised if the surrounding rules are not enforced strictly. In addition, the rules that have been determined and implemented in the first place have a very low rate of conversion in later stages.

3.7.2 Private Blockchain

In contrast to the public blockchain, private blockchains are the only ones shared among trusted participants. Complete control of the network is in the hands of the owners. In addition, privacy blockchain rules can be changed depending on different levels of permissions, disclosure, number of members, authorization etc. Private blockchains can be run independently or can be integrated with other blockchains as well. These are often used by businesses and organizations. Therefore, the level of trust required between participants is high in private blockchains.

Benefits of Blockchain Technology

- Extended overtime due to real-time transactions
 - Direct transactions exclude additional costs and mediation
 - Reduced risks associated with cybercrime, fraud and harassment
 - Many clear procedures for record keeping and tracking
 - Highly secure due to cryptographic and decentralized Blockchain protocols
- Technical background and development.

3.8 Examples of blockchain technology implementation

Blockchain technology has been developed under a digital book named Satoshi Nakamoto's Bitcoin and many people think these two the goals are the same. But Blockchain and Bitcoin are completely different. Bitcoin was the first system to use blockchain technology, too especially Bitcoin fulfilled its potential. Bitcoin is an open source, peer-to-peer crypto-currency that existed developed by Satoshi Nakamoto in 2008 and launched in 2009.

IBM Open Blockchain and Hyperledger Fabric

IBM OBC was created with the idea of blockchain technology can be well viewed with many functional and providing networks different purposes. IBM is part of the Hyperledger Project, Linux basic project. The main purpose of this project is to promote blockchain technology for key identification and speech features of the industrial level open to distributed ledgers. (Cachin, 2016).

The program used at IBM OBC is self-contained and does not perform you need any other network requirements. Like Ethereum, OBC uses “Conversion finish”. (Cachin, 2016, 2).

Hyperledger Fabric allows for many different uses of Blockchain; therefore, it allows the creation of different levels of consent. Due to the ability to encrypt transactions, participants can hide their identity, patterns of action and terms of confidentiality agreements from third parties. The Hyperledger fabric relies on the Byzantine Fault Tolerant algorithm to a secure network connection, different from Bitcoin using proof of labor mining. (Kakavand et al., 2016, 12).

ErisDB / Tendermint

ErisD, like Ethereum, is a blockchain open-source platform for building, testing, storing and implementing digital systems. The main difference between the two platforms is that ErisDB allows the construction of approved and licensed blockchains. This the platform was intended for use in many different locations. ErisDB supports EVM, so any smart contract code is written for you Ethereum can also work on the ErisDB blockchain. This is the court is intended to allow the easy construction of digital applications for users. In addition, it has established its own platform, using Tendermint's consecutive law of consensus. The Tendermint project includes open-source Implementation of the BFT protocol for smart contracts. (Kakavand et al., 2016).

R3CEV

R3CEV is a technology company, which aims to research, develop and improve blockchain integration in the financial sector and financial construction grade ledger. The firm expects to apply for financial and regulatory facilities bodies to be involved in the creation of a standard-level ledger.

3.9 Blockchain and IoT

Blockchain is a paradigm for transforming the whole community and Internet of Things. Perhaps it can be called the allowable amount of mechanical economy. According to Gartner, (2016) there will be 26 billion devices and 1.9\$ trillion economics by 2020. As a result, “the Internet of Things “Money” should govern transactions between all these devices (Omohundro, 2014, 2), and micropayments can grow into new ones

the economic layer (Singh, 2014, 1). Connect to M2M (machine-to-machine) sphere grows faster than any other. The machine the economy can provide a fast and efficient system of land redistribution managing and distributing resources on machine scales, such as money economics allows you to do it on a personal level.

A visible example of M2M micropayments would be automation “intermediate” dialogue connected to each other's cars in highway speed. When they are fast, a strong little road peers in a relaxed system. The following example would be drones, especially to coordinate their air delivery by them with the device- to- device micropayment device. The agricultural sector is possible developed with blockchain alike. Their senses can use economics principles for filtering standard data and filling the database extensively appropriate, depending on natural conditions. (Swan, 2015, 13).

Often, at the most basic level, blockchain technology is still being distributed an unreliable peer-to-peer transaction model means no middleware transactions. However, a major overhaul of the system on a large scale a global foundation can mean a completely different function of humanity in sectors that have not been anticipated, but where the whole system could be easily free its use. (Swan, 2015, 22).

3.10 Applications of blockchain

Blockchain technology is a digital, distributed, and distributed platform that represents the most tangible funds responsible for accessing all payments without the need for a financial mediator, such as a bank. In other words, it is a new way of transferring funds and login information.

Blockchain is the understanding of developers who believe that the current banking system is flawed. They viewed banks operating as foreign companies and taking transaction funds unnecessarily and ridiculed the idea that payment verification and payment could take five business days if cross-border transactions were performed. With blockchain, real-time transactions are possible (even cross-border), while banks are left out of the equation altogether, possibly reducing purchasing power.

Apart from financial planning, there are other uses of the blockchain. Various elements of the Dow Jones Industrial Average are exploring some of these applications in small projects and demos currently controlled.

3.10.1 Financial markets

Clearing, trading, and replacing a mediator

Payment of financial assets and removal is customary activities of the banking sector. In the U.S., Canada, and Japan, where is a three-day round of stay, with the EU, Hong Kong and South Korea, this cycle lasts for two days (Peter et. al., 2015, 26). This is one day

The difference can bring many risks related to monetization and credit. That why in the U.S. the Federal Reserve has pressured all stakeholders to act increase the payment termination (Kiviat, 2015-2016, 585-586). Some say the blockchain not only delivers value, but also covers several parts of the pay-per-trade price chain in a effective and efficient way (Kiviat, 2015-2016, 569, 587).

Therefore, the trade and clearing sector is one of potential blockchain applications. Blockchain technology can change the process of removal and retention through the distribution of power to communities and the non-alignment of power.

The blockchain can make the cycle of staying a waste of time (Peter et al., 2015, 28). In addition, back-office costs can be reduced through use Blockchain technology for all reporting, compliance and securities Management can be managed (Peter et al., 2015, 28). Also, an important factor in using the blockchain is that the set amount will not be available allowed to release until each party is satisfied with the actions of other. It will be useful to add a third-party digital signature transaction or multiple teams, play a role in ensuring performance. (Shadab, 2014, 14).

However, there are critics who think Blockchain is always going to be more expensive than central clearer because the processing work will be done by many agents, not individually. This will depict such clearing service as not cheap (Maineli et al., 2015).

Payment system

These days, all payments are checked and verified by a third-party authority, so experts in the industry predict that it is allowed Blockchains will play a key role in paying by 2020. The first bank that has decided to introduce Blockchain technology internationally payments were Santander UK in June 2016 (Kakavand et al., 2016). Especially in the U.S., unused financial services such as blockchain payment companies are traditionally regulated.

However, there is a possibility that the rules set out licenses as well sender compliance rates can be improved if the number of blockchain-based systems is rising. Yet there are several blockchain-based payment providers that may be subject to a fee the Business Services Regulations (MSB) issued by the Department of Treasurer's Financial Crime Management Network (FinCEN) (Swan, 2015). The EU, on the other hand, has a similar legal framework for which controls electronic money.

Operating risks in financial markets

Deleting mediators applies to the regulated business category called financial market infrastructure (FMI). The Federal Reserve says that FMI includes a program operator that pays or records payments, security, acquisitions or other financial transactions (Walch, 2014, 851-852). Therefore, FMIs are controlled. Due to blockchain used technology, there is no need for a reliable consultant who can represent operational risks. As a result, the blockchain system will take the lead in the automatic use of commercial clearing or payment system. (Kakavand et al., 2016).

Smart contracts

Initially, the blockchain was developed to improve cryptocurrencies, however entrepreneurs are now developing a new way to use the blockchain smart contract. It is an agreement between the parties with the code as well uploaded to blockchain. A smart contract does not depend on a third-party team manager. All the procedures for dealing with these contracts are as follows it is automatically controlled. Contract clauses are done after all teams have accomplished their tasks. This operation removes everything ambiguity regarding the execution of contract conditions in respect of the presence of external dependence. (Swan, 2015). Wise contracts can make the negotiation process and the performance of the contract is simple and efficient. Usually, a smart interface the contract is clear and mimics the concept of contract clauses. The key aim is to protect contractual processes and reduce related costs to contracting. (Kakavand et al., 2016).

One of the key features of the blockchain in a smart contract is empowering Unscrupulous transactions. This type of transaction is defined as guaranteed, targeted performance and validation across the digital network. Smart contracts can also include multiple digital signatures where needed approval of participants. If the terms of a smart contract depend on it on top of real-world data, programs called "oracles" can be made to monitor and verify this data. (Swan, 2015, 25).

Another possible use of smart contracts is financial transactions. There are various aspects of intelligent contracts benefits the industry. For example, a margin can be automated transferred to margin calls, and if there is a default, the contract may terminate. Because of the "final tasks" of blockchain, record keeping, auditing and archiving operations it is possible to reduce labour costs for teams. (Kakavand et al., 2016).

Although the use of smart contracts may be limited, their use is possible increase the automation of contract processes and reduce them related labour costs. A smart contract is a double standard for a real contract in a digital network. (Swan, 2015, 27).

3.10.2 Other industry applications

Blockchain could provide not only financial applications but also disruptive applications in other industries as well.

The real estate industry

Blockchain can be used in both real and private real sectors the construction industry. All information relating to land registration records and public land ownership records can be easily uploaded to the blockchain.

This opportunity will allow the relevant stakeholders and agencies to have access to ID data. This greatly reduces the number of conflicts and the need for a third party, so it is saved time and cost of consumers. (Kakavand et al., 2016, 19).

Information about private companies, such as rental housing agreements between private partners, can be uploaded to blockchain. Also, smart contracts can be a great way to improve housing industry. This will control the flow of work in the buildings agencies and save resources and time. (Kakavand et al., 2016, 19).

Healthcare industry

There are various uses of blockchain technology in healthcare industry, for example, end customer delivery pipeline. Throughout this process, drug packages are guaranteed, time stamped and embedded in the blockchain at each delivery point. Therefore, the drug packages can be tracked. Blockchain enables distribution of the medicine is clear and safe because it can prevent the medicine from entering theft and reduce the chances of price control and delivery of expired drugs. (Gilbert, 2016).

Smart government

Instant access and instant access to archive database public records are of great benefit to government agencies. A good example would be ownership management. Still, there is more space to improve blockchain in the industry, but apps that it will be the result of that kind of work that will advance the whole sector in the next level. For example, the installation of passports or driver's licenses in the blockchain can allow different agencies to verify identification in real time. The Estonian government is trying to do just that blockchain-based solutions. (Stone, 2016).

Regulatory and tax applications are also a good example of using blockchain technology. Most banks are operational using blockchain-based systems. As a result, when regulators do similarly, they can directly and automatically set limits performance of tasks. This fact leads to the reduction of compliance with the law and the cost of auditing. Financial transactions can also work be taxed automatically since the ledger follows the transfer of ownership of assets, as each function is reflected in the relevant tax organizations (Deloitte, 10). This further reduces the need for various mediators in this process (Kakavand et al., 2016, 19).

Foreign Aid is another fascinating blockchain technology program. External assistance can be used efficiently using the border transfer to reach the target location (Swan, 2015, 61). This fact provides it is possible to avoid corruption and mismanagement (Kakavand et al., 2016).

Last, but not least, there are plans to vote on Smart government. Blockchain technology can help improve itself. Through the blockchain, everyone can vote on this anonymous judge, and all results can be calculated and defined without stakeholder ownership (Swan, 2015). As a result, the top polling station will be removed.

Artificial intelligence

Installation ingenuity is a new area of integration with the blockchain. Applications based on blockchain in this field will have long-term access results in the future. These days, smart contracts work in the “narrow ingenuity”, but they can be organized to accomplish different tasks in accordance with the pre-determined rules and regulations. Development of the blockchain will lead to the use of smart contracts implementation. Integration and artificial intelligence can help nodes in the blockchain to create themselves independently. (Kakavand et al., 2016).

The consequences of this merger are likely to follow, according to Kakavand et al., (2016).

- Negotiations between nodes in a blockchain in assets price availability.
- Access to financial asset ownership networks.
- Blockchain nodes work together to increase home power use within the broader Internet of Things model.

3.10.3 Applications for Supply Chain and Logistics

Supply chain is defined as a line of various points involved in production and delivery of goods, from the procurement phase to the end of the customer. Nowadays, transactions can contain various categories and locations. As a result, it has become increasingly difficult to follow events completely series. Moreover, due to the lack of visibility of the sale, consumers and customers cannot be sure of the actual value of the products either services. Also, there are a number of factors associated with the sale of goods that cannot be traced, like natural phenomena. (Dickson, 2016).

It is difficult to investigate the accountability of illegal events associated with it supply chain. Because of these challenges, the world today is facing a crisis following fraud, forced labor and poor conditions in industries.

Blockchain, as a provider of visibility and security insurance, could be a good thing Chain supply chain solution. Even the simplest use of blockchain technology can bring excellent transactions. Registering the transfer of products to a digital ledger as a transaction allows you to identify the key data relevant to manage the purchase process.

Key blockchain features can be very helpful in the use of procurement series: (Dickson, 2016) Public availability provides an opportunity to track product from location from end customers.

- The distributed structure provides participatory capacity all groups in the supply chain
- Cryptography-based and non-Cryptography environment provides security guarantee.

To date, several attempts have been made to use blockchain for to improve Supply Chain Management. IBM is a pioneer in this field attempted to undo blockchain power on procurement series. (Dickson, 2016)

Walmart

Walmart is a major US company that sells experimental project distributed ledger technology to track the origins of pork in China as well production in the U.S. The project was scheduled to start in the first quarter of 2017 and will take four months. (Ramamuthy, 2016).

It will be one of the most important test projects in blockchain technology outside the financial sector. These technologies can provide coping power with errors and deadlines missed so make the offer chain works very well. In fact, especially that field is what it is most focused on blockchain applications. According to the latest data, 42% of companies in the retail and manufacturing sectors plan to spend \$ 5 million in this type of technology. (Ramamuthy, 2016). Walmart will use a technology platform based on IBM's technology for Linux Foundation, Hyperledger cloth (Prisco, 2016).

Everledger

Everledger is a start-up that aims to reduce risk and bank fraud, open and guaranteed markets. It uses blockchain technology, a machine vision, smart contracts and other emerging technologies. The factory wants making diamond delivery transparent and helpful to end the use of forced labour across Africa.

The platform operates in a global, digital ledger that enables tracking goods throughout the supply chain. Records in blockchain contain to describe features, history and ownership, and all components in the supply chain can use them at any time. (Dickson, 2016).

Everledger has developed a hybrid technical model that uses private and public blockchains. This allows them to work better in the industry in which they work. The firm takes a rightful place in the Hyperledger community, committed to simplify new technologies in the supply chain.

Provenance

Provenance is a London-based company that aims to offer it clarify more clearly by using blockchains that make companies more reliability in their operations, including the environmental impact on the place of origin of the products and who made them. The company is led by computer science PhD student Jesse

Baker. He told IBNimes, that are very concerned about how the data is presented consumers are also very focused on achieving that details, and how they are presented, in the product or in-store.” (Alloson, 2016). In addition, Provenance will use blockchains to eliminate the employee exploitation or other bad habits, because the details are correct available on blockchain ledger can be many. (Dickson, 2016).

There are several problems in the global logistics industry, such as lack of transparency or misunderstanding between agents is different layers of feed chain. As a result, many challenges are related the law of transportation and the origin of the product (Williams et al., 2015).

This contradicts customer interests showing off is considered the key to a successful business. Sharing details between all groups in the feed chain can improve relationships between them and make them work better (Lamming et al., 2001, 4-10). It was a real challenge to find a transparency program before the blockchain arrived. Blockchain can be productive transparency and ensuring the fulfilment of transport contracts. These are several aspects of blockchain features that can help improve goods industry:

- Opens access to information related to internal functions the sale of goods (Baker et al., 2015).
- Empowers customers to test product, service, supplier, administrator etc before deciding (Baker et al., 2015).
- Provides customers with the information you need in respect of product origin and product line (Ho-Hyung, 2013).
- Reduce the risk of fraud or counterfeit goods (Hancock, 2016, 15).
- Allows monitoring, tracking, and tracking of traffic (Baker et al., 2015).
- Facilitate the exchange of goods and payment systems (Nakamoto, 2008, 7).

Unfortunately, the lack of transparency is not the only challenge material management. There are a few key issues that affect this sector: (Lieber, 2017)

- Organizations do not share all relevant information with others they did not participate, so they chose to defend it against them.
- Large amount of information related to products or texts can be easily lost in any given series.
- None of the groups share information about location of equipment to determine quality.

Fortunately, blockchain can solve these problems. According to a recent report by Expert Insights of IBM Institute, Blockchain was technology to be used in various supply chains looking at the benefits of visibility, efficiency and prediction. (Lieber, 2017).

Many current paper submission processes are required, viz it often results in various costly errors. In a blockchain system, everything Information relating to shipping processes will be digital, allowing for that all participants to obtain relevant information at any time. As a result, this reduces the risk and increases the quality of delivery. Moreover, it will allow organizations to reduce the amount of waste.

Blockchain is useful for managing by enabling compatible testing methods between partners and use them in real time. It will boost trust beyond the supply of goods, which makes it easier to make decisions process at all stages. (Lieber, 2017).

Finally, enabled and instant access to digital data the ledger may allow for the cooperation of all parties. Companies should use blockchain technology to build efficiency relationships with their partners, make their business visible to customers and prevent multiple errors throughout the supply chain.

3.11 Disruption in supply chain

Changes and paradigm shift in the supply chain

Regarding production and supply processes from industrial construction, where there have been several steps forward in terms of process efficiency and information exchange. Nowadays, new technologies are quietly changing the process of production well. This crisis requires not only technological know-how but also a strong leader remove strategic planning and influential groups among participating stakeholders' owners. Thus, Gray (2017) describes a major change in blockchain-induced paradigms chain, namely the development of digital transformation. That means global participants connected and benefiting from emerging trends such as the construction of value networks, multiple data form, for example, open-source data, intelligent and independent feedback as well localized processes.

Several European organizations, according to Van Wassenhove et al. (2007), talk with regard to procurement interactions in the sense that supply chains are in a connected to the status and communicate regularly with each other. Crops and collections, produceding, can benefit from the connection and availability of integrated information available. Therefore, Korpela et al. (2017) consider several benefits of so-called digital supply chain (DSC). It includes cost-effective services and value-added services are beneficial to many actors in the natural supply system. Visible with exchange of strategies and performance cohesion and in general, integration within an organization is achieved through electronic links between information systems.

In addition, Mirando et al. (2019) add that technological advances should be affected how people participate in the production process of supply. So, three types of inter-actions can be applied to new products, i.e., human interaction, with less technical content and human machine and machine collabo assignment. The wide variety of technologies and devices included in this process will result in a more independent system supported by ledger solutions such as blockchain. In addition, Treiblmaier (2018) demonstrates that with the advent of new technology, the way it is deliver chain structures are held, obviously changes. From a resource-based view (RBV), explaining how to take advantage of competitive use of resources effectively skills, possible blockchain modifications could lead to changes in existing boundaries arise with the increase or

decrease of the appropriate source. It means blocking the transformation of the chains offers opportunities that extend beyond the existing ones. An interesting aspect of how the future offer may be giving the Gromovs & Kammi (2017) included in the smart map building three steps of ethics at the forefront of real estate marketing processes. According to a study by IBM Company, these smart supply chains, meaning they include analytics, simulation models, carbon steps, speculation and business intelligence analysis, among others. In addition, connection and real-time visibility, required network, interactive KPIs and collaboration platforms are real. Eventually, the mechanical data will replace the people creatures in the form of radio-frequency identification tags (RFID), sensors, actuators, counting list and container content.

Overall, Tholen et al. (2019) write about the fastest growing digital assets in financial world. Non-digital assets are assets and raw materials are acquired as digital twins while using tokens. However, the token created is only as reliable as the party that started it, so the act of fraud can still happen without the right government rules and regulations.

Insufficiency within supply chains

Scholars such as Zhao et al. (2019) argue on the subject of food supply in four different contexts, indicating poor sales performance. This is tracking, production, sustainable resource management and information security. Lack of clarity within the topics described above lead to very fast price chains. According to Barner (2019), visibility is needed from end to end, especially in the supply chain, both to make sure companies can label their products with confidence and protect other products the spread of disease due to pollution. Several challenges in delivery Proper diligence due to chains is described by Tholen et al. (2019), emphasizing the fact that Today's supply chains are fragmented, complex and dependent on a large number of providers and mediators from around the world. Therefore, this leads to information on commodity trading, which prevents companies from doing the right thing by identifying risks, prioritizing activities or tracking assets and reporting statistics accurately.

Although there are proven programs such as nomenclatures and practices, it participates in built in the same digital language, there is still plenty of room for improvement as well to facilitation. In addition, due to the cracking of the supply chains on the most complex vehicles with many participating actors, understanding and classification of difficulties and likes. The problem of accidents is difficult to reach. This inaccuracy of risk information puts pressure company value chains, for risk information to be used the requirements of a particular time are reliable and but also comparable and accessible. Examples here are the risks of bribery, tax evasion, employee conditions, person copyright infringement and more. In addition, many commercial players tend to be different because collecting information from sub-suppliers and retailers in key locations

in chain because local governments in some countries simply do not need the right government a database of relationships between feeds.

Abeyratne & Monfared (2016) mark that it is challenging to have a complete picture of everything that is done within chains, especially in a multi-supply system. Details, for example, contracts, financial transactions, transactions in goods or services and system included in today's acquisition plans, usually stored in many places as well they are only available to certain components of the system.

In addition, Casado-Vara et al. (2018) confirms the procurement sector problem that its measurement can lead to delays and instances of delivery of goods and other matters within the delivery process. In an effort to solve the problem, consider the automation as a result, accompanied by a significant increase in the number of distributors in supply chain. However, that means the risk of information attacks is greater and hackers' intentions may be to alter, delete or steal important data. It is the result access to better performance management features, customized asset controls, event alerts driven by automatic data feeds from operating partners.

Expectations of stakeholders in procurement

The various buyers around the world are realistic, unique, times that separate interests and needs. From a customer's point of view, for example, there are many reasons why product purchases are important. Montecchi et al. (2019) see the high level of risk that customers perceive when their information is hidden in the file product series. This so-called accident risk can affect customers' clean-up. chase decisions and attitudes because details of asymmetry can lead to unwanted results or customer results. Halder & Party (2011) show an example of the Indian population that due to population growth, demand and exploitation patterns change a lot so, these people just want enough availability of the products they need. According to Matati (2016) firms themselves are expected to keep them track of legitimacy within the networks of their providers, which can be very complex these days, but right now they can't do it right. Other than that, customers are managed they lean heavily on their ability to explore the origin of material or morality aspects of how product manufacturing takes place. In addition, customers want with more democracy in sales. Now, when rebalance of power in supply chain network can be the result of customers aspirations to edit each step in the supply line in the way they like, using the specified resources as well suppliers of a product that is accurately produced as the customer wants, it can be said great paradigm flexibility. Some similar customer objectives are defined by Westerkamp et al. (2019), which emphasize the most important aspect of asset compatibility certain levels of nature and behavior. Customers expect to know where the goods came from and how they got into their goods. Similar from Abeyratne & Monfared (2016), who added that at present, there is an improvement in the overall need for improved access to information to restore consumer confidence in products.

The expectation is a high level of awareness of the various events that may occur in supply chain. Consumers more than ever are encouraged not to accept any information without being able to confirm and properly understand what is said behind it. The examples of abuse of trust in reputable companies are the emissions scandals of Volkswagen in the year 2011 and Nissan in the year 2016.

Many standpoints arise from strategic and operational decision makers chain-based companies that bring in Chang et al. (2019), referring to the period of business tracking process (BPR) as a renewal process within SC. It is written as a way to rethink and redesign business processes for profit the development of modern critical occupational measures, such as service, quality, cost and speed.

The valid point here is the fact that the re-use of new technology quires changes and methods vary compared to how organizations perform general functions. In addition, Tholen et al. (2019) debate the importance of satisfying voluntary policies e.g., guidance within the OECD guidelines. This includes embedding a responsible business compliance (RBC) with procurement policies and management systems, in accordance with the law communication reconstruction, identification, testing and tracking of adverse conditions lungs. In developing this framework, businesses may face direct and indirect issues their ability to carry out commendable hard work. Usually, snowballing a tendency to more visible and more reliable expectations of consumers, regulators as well investors in respect of responsible business conduct globally and determined beyond various economic sectors.

This study is based on Beamon (1999), where a framework is proposed in which three different performance measures are linked. The first performance measure is Resources. Efficiency is the main objective of the performance indicators that fall into this category, and profitability is directly affected by this variable. The output is the second phase of this framework. The purpose of performance measures in this category is to deliver quality customer service and to ensure that customers do not switch to competitors. The third and final type of performance measure Adaptability. The common goal of performance measures in this phase is to ensure the correct adjustment of the supply chain to change. These three types of performance measurement are accepted as phase matrix components, as they provide sufficient variability between different performance measurements.

3.12 The Power of the End Consumer

Min et al. (2019) designs the creation of customer value as the main driver of operations in a supply chain. Supply chain-driven projects have come into being as part of the digital revolution. The latest innovations

enable companies to respond more accurately and timely to customer needs. In general, the end customer assumes a high level of channel power in the supply chain. These capabilities allow them to look for enhanced products - with service offerings, lower prices, and different customization. The suitability for purchasing and exporting products is expected to be equal across all digital channels, offline, direct and indirect (Min et al., 2019). The expectation of customers to be able to purchase the product through various physical or digital channels poses new challenges in supply chain, implying the necessary changes in supply chain design (MacCarthy et al., 2016). Companies have been tasked with finding unique ways to meet the growing needs of customers through advanced production and transportation solutions, which place a greater amount of pressure on supply chains. In addition, there has been a recent shift to an economy based more on product sharing than on full ownership. This means an increase in the need for adequate asset management. Consumers are also increasingly concerned about the consequences of their use. There is a growing desire for products to be purchased, manufactured and shipped in a sustainable manner and to have easily accessible product information. This need for sustainability and transparency raises costs and forces organizations to find the right balance between profit and sustainability (Min et al., 2019).

3.13 The Deployment of New Technologies

Groznika & Trkman (2015) named Information Technology (IT) as an integral part of supply chain management. IT can facilitate the transfer of information in an organization, as supply chain management involves both internal and external systems. Creating a shared IT perspective, processes and operations are seen as a major challenge to the adoption of IT in the supply chain management (Groznika & Trkman, 2015).

A variety of new technologies have recently been introduced in various supply chains. Examples of the latest innovations include Internet of Things (IoT), Data Science, blockchain, 3-D printing, and robots (Min et al., 2019). The power of data propagates a large portion of research interests in the supply chain domain (Groznika & Trkman, 2015). Smooth data management to the end is the essence of modern-day management. This simplifies real-time data and transparency. The value of these relevant technologies can be improved through interaction with others. The implementation of this technology is designed to have a significant impact on supply chain, organization, infrastructure, and management (Min et al., 2019).

3.14 The Necessity for a More Resilient Supply Chain

The supply chain's ability to handle disruptions has gained considerable importance in recent times (Monostori, 2017). According to Kilubi (2016), supply chain risk management is an integral part of modern supply chain management, which has the company's competitive advantage in risk of threats if resilience is

not managed properly. A variety of catastrophic events, such as natural disasters and financial crises, have hit the asset of recent times, the most threatening activities. The ripple effect, which includes the progressive impact on different businesses, is a potential consequence of process disruption. The severity of this effect is influenced by the presence of buffers, as well as the speed and level of recovery.

Recovery speed is very important, as a quick recovery can provide continuity and no long-term consequences. Therefore, disruptive events require that supply chains have the right application in an emergency. Recovery policies are an important driver for improving supply chain strength. Managers need tools to analyse the durability of a supply chain, to understand how recovery measures affect the supply chain in the event of various disruptive events (Ivanov et al., 2017). To meet customer expectations, processes and designs may need to be radically modified during disruptions. The need for transparency is emphasized, and the uncertainty in demand forecasting and the timing between orders that arise when the flow of supply chain chains is not sufficiently apparent to management (Kilubi, 2016).

3.15 Modern Supply Chain Management Methods

Lean supply chain management, which focuses on waste disposal through a step-by-step approach, has been a major benefit in recent times. Reduced methods can be accepted by many types of supply chain and therefore hold widespread appeal (De Angelis et al., 2018). It is especially interesting to provide chains where the cost should be significantly saved. However, supply chain mechanisms can increase the risk of process disruption when the focus is on efficiency rather than efficiency. Recent advances have been the switch to more traditional methods, which include increasing the response to potentially disruptive events. These developments have accelerated the increase in uncertainty and volatility in world markets and may include more costly approaches to provide the required level of response (Christopher, 2015). The increasing incidence of events that cause supply chain disruption has prompted companies to switch to hybrid supply chain construction, rather than sticking to a rigid or too fast route (De Angelis et al., 2018).

3.16 Blockchain & Supply Chain Integration

A blockchain in supply chain can help participant's record price, date, location, quality, certification, and other related information in order to effectively manage a supply chain. Access to this information within the blockchain can increase the supply chain, lower losses from fraudulent and Gray markets, improve visibility and compliance with foreign contract production, and improve the organization's position as a leader in responsible production. Using the blockchain in the supply chain can help participant's record price,

date, location, quality, certification, and other related information in order to effectively manage the supply chain.

3.16.1 Disruption Power

Supply chain management is seen as one of the fields where blockchain-based solutions can have the greatest impact on transformation (Niranjanamurthy et al., 2018). Kshetri (2017a), predicts that supply chain processes are business processes that blockchain technology is likely to disrupt. It is seen as a powerful innovation in providing solutions to many of today's supply chain challenges (Calatayud et al., 2019), including challenges from emerging global environments that illustrate multiple supply chains (Saber et al., 2018)). The introduction and evaluation of advanced supply chain management software is a major breakthrough in blockchain research. Technology has the potential to generate real returns on early investments and is well suited to the complex flow of work in a supply chain (Kshetri, 2017b). Kamble et al. (2018), believe that the blockchain will create a significant paradigm shift in supply chain processing.

In some industries, supply chain transformation is intended to be the most important. Kshetri (2017a), estimates that supply chains in the food industry can be expected to be significantly transformed by blockchain technology, as the reliability of suppliers is crucial in this sector. Blockchain technology can promote the development of this feature through the provision of a proven track and efficient operation and balancing process.

Wang et al. (2018) determined that blockchain technology could have an impact on the management, formation of relationships, and the performance of functions in a supply chain. This is driven by secure data exchange. In addition, product availability, compliance, and product compliance with regulations can be improved. This will be done through improved product visibility throughout the series, which can be established through a combination of blockchain technology and additional technologies.

3.16.2 Blockchain Integration in Shopping Chains

Blockchain is seen as an additional technology that can connect different ERP systems and make transactions between organizations easier by using all transparent, shared record views. Integrating blockchain with various technologies is therefore the basis of the implementation process (Cole et al., 2019).

Supply chain management will depend heavily on Internet of Things (IoT) applications. Assets in the supply chain network can be tracked in real time with the Internet integration of Objects and tracking devices that transmit data continuously. This allows you to monitor multiple values that affect product quality, such as temperature, location and humidity. This allows interventions to ensure product quality is not compromised. Consumers can be provided with reliable and important indicators of sustainability. Consumer confidence and willingness to make a purchase decision may increase in the following (Kshetri, 2017a).

The combination of blockchain and IoT can be a low-cost business solution (Cole et al., 2019). The integration of blockchain and IoT technology enables connected devices to record data verification, securely and permanently (Kietzmann, Archer-Brown, 2019). Christidis and Devetsikiotis (2016) argue that integrating blockchain with IoT can transform many industries significantly, and that integration facilitates the development of new business models and technology applications. The logistics area is seen as one of the domains where the combination of Internet of Things and blockchain has great power. This is due to the large number of smart devices that can be present throughout the supply chain (Tijan et al., 2019).

Calatayud et al. (2019) researched the concept of a hypothetical supply chain, a supply chain driven by the development of completely independent information technology and the ability to speculate. This supply chain design is seen as a powerful potential for the future and is being described as the beginning of a new supply chain energy era. A series of self-service offerings are proposed to provide significant improvements in efficiency. Blockchain is seen as a technology that completes and strengthens this chain of provision for the future. The combination of the concept of self-thinking supply chain and blockchain technology is intended to drastically change the flow of supply chain.

3.16.3 Supply Chain Operations by Blockchain

Cole et al. (2019) state four steps related to the blockchain deployment process in supply chains. The first phase is the Development phase, where technology meets certain needs in the organization. Phase Two Examination, in which the decision to adopt blockchain technology is tested. Implementation is the third phase, which involves the transfer of technology to the supply chain. The fourth and final phase is Integration, which integrates blockchain integration with other technologies.

Saberi et al. (2018) identified four new businesses that are thought to play a key role in supply chain blockchain technology: 1) Subscribers: Providers of unique ownership to users. 2) Standards organizations: Businesses that define the standards, policies and requirements in the blockchain. 3) Certificates: Certificates are responsible for verifying the trust of the system by providing certificates of participation to participants in the supply chain after successful testing. 4) Actors: Other groups such as manufacturers, suppliers and customers. These are the recipients of certificates following successful testing. Depending on the structure and purpose of the network, industrial competitors can be integrated into the same network (Wang et al., 2018).

The supply chains will need to make major changes to reap the benefits offered by the blockchain (Saberi et al., 2018). Wang et al. (2019) suggests that a supply chain that includes blockchain-based solutions should be a value platform. Value in this forum should be created by engaging players through established practices.

Network supply chain networks based on blockchain technology will likely be allowed, limiting the number of participants. However, small supply permits can also play a role. Interactions between network participants can be explained by smart contracts. Smart contracts can help further process processes and data sharing between participants. Authorization may be required in order to achieve the specific procedures set for certain players, which may require agreeing to contracts in smart contracts (Saber et al., 2018).

3.17 Blockchain Supply Chain Implementation

3.17.1 General Impacts of SCM

First, a distributed network design allows the use of real-time data by each participant connected to a blockchain network. Also, smart contracts can automatically provide for processes where conditions are met. Third, the blockchain makes the supply chain less dependent on central mediators, distribution authority. In addition, the fact that data is not static provides opportunities to improve experimental processes (Cole et al., 2019).

In addition, Information about who, when and where the action taken can be registered on the blockchain. Providers are allowed to monitor the status of shipping and delivery (Kshetri, 2017a). Blockchain may be used for the registration of certain information, including the time, place, cost, ownership change and the organizations that were part of the transaction. The materials and repairs they face throughout the supply chain can be considered. In addition, the blockchain enables the registration of product updates and exchanges, making it easier to identify product risks (Kshetri, 2017b). Products may have a unique digital presence on the blockchain in the form of profiles that can be accessed by program participants. Product features including properties, quality, quantity, location and ownership can be accessed by system participants through this profile. Actors have their own profiles that, like brands, reflect information about the business. (Saber et al., 2018).

3.17.2 Improving the Openness of the Supply Chain Series

According to Wang et al. (2018) and Xu et al. (2019), the most important blockchain application and that stimulates the proliferation of the field of asset management is product visibility and tracking. Product tracking includes processes that allow the creation and distribution of goods from the beginning to the end customer. In modern supply chains, the help of private tracking companies is often hired to hire products throughout the supply chain. These companies award certificates when the product requirements are met. Products can be digitally tracked through production and distribution processes through a tracking system.

In their current form, these systems tend to have a centralized site under the control of the organization, which is prone to collusion and set to have a single point of failure (SPOF) (Xu et al., 2019).

Platform- based platforms are ineffective in collecting and authorizing supply chain data. However, transactions powered by blockchain technology provide greater clarity for participants, as individual transactions across the supply chain can be tracked through the creation of blocks. This creates a testable, beneficial path to supply chains where provenance is important (Wang et al., 2018).

Product Disclosure - Testing the availability of a portable product is an important issue in modern supply chains, and one of the most widely used case cases is blockchain technology (Kim and Laskowski, 2018). In Wang et al. (2019), blockchain-enabled emergence has been identified as a critical factor with a significant impact on process security. However, provenance can be difficult to determine due to the complexity of modern supply chains.

According to Kshetri (2017a), complex supply chains are lacking in both transparency and accountability. Supply chains are generally international and contain large networks of participants involved in a growing number of product life cycle stages. In addition, it may be difficult to create a single product idea, as different parties often have their own version of product information documents, with limited access to selected actors. Step-by-step testing of product emergence with current solutions is therefore not always possible (Montecchi et al., 2019).

The integration of blockchain and Internet of Things is aimed at improving supply chains through product enhancement. The source of the information has become easier to determine due to the growing amount of data needed to identify a digitally available source (Kim and Laskowski, 2018). Blockchain allows source determinations, verification and authenticity, tracking product storage, and product path verification near a supply chain from your source to the customer and possibly including after-sales services. All product-related transactions in the supply chain can be verified by a shared and similar view of participants (Montecchi et al., 2019).

Benefits of Improved Process Testing - Many benefits of improved product tracking and identification of their use are identified. First, consumer confidence in the product may increase, making use of blockchain technology a direct trade option. Organizations are expected to be more transparent to consumers, thus gaining the need for improved visibility of the product life cycle (Montecchi et al., 2019). There is a social trend towards a willingness to better understand the origin of products and to identify factors such as location, environmental composition, authenticity, and sustainable production (Nam et al., 2019).

Apart from the existence of programs to improve visibility, consumers often do not have much information about the source of the product, production standards and adjustment of the supply chain. Customer knowledge of your appearance is insufficient due to physical distance, unusual purchases of a particular product, or limited ability to test performance. Consumer knowledge of lifestyle and assurance in decision-making can be enhanced by the perceived reduction of financial, psychological, social, occupational, and physical risks. Consumers become more confident when shopping when they are given accurate information about the conditions and methods of transport and storage of the product. A competitive advantage can be obtained by removing any doubts that customers may have about purchasing a particular product because of doubts about the product's appearance. Organizations that sell expensive, highly involved products can benefit from using blockchain technology (Montecchi et al., 2019).

Significant improvements in speed can be seen in the integration - blockchain-based product tracking, which organizations can use to quickly implement security measures. Immediate intervention when product safety is at risk may be important in stopping the spread of diseases caused by contaminated products (Wang et al., 2018). Additionally, a blockchain can be a wise investment for organizations involved in the supply chain for fraudulent products. Blockchain can also be used to authenticate products that are often counterfeit such as clothing and medicine. Secure digital companies can be allocated to tangible assets, making it very difficult to commit fraud (Montecchi et al., 2019). Consistency of information plays a major role in this. Since ownership is detailed and cannot be changed by unauthorized parties, improper seizure is made more difficult. Characters who commit atrocities can be banned and prosecuted.

3.17.3 Division and International Classification

Disintermediation - One of the main assets of the blockchain is the provision of split management. Transactions in the blockchain contain individual authentication and authorization methods that allow for independent verification and termination of transactions. This eliminates the need for an external centralized company that manages website sharing.

The use of Blockchain in chains to provide segmentation is becoming increasingly common. Blockchain enables communities to take intermediary services such as processes such as search, contract, auditing and setting up payment methods can be eliminated at very low cost (Manski, 2017). The size and layout of relationships throughout the supply chain will be greatly affected by blockchain-based solutions. Technology can authorize the transition from interaction to more interaction with smaller, more global organizations (Min et al., 2019). Manski (2017) also emphasized the importance of non-involvement in supply chain management in co-operatives, due to the importance of ethical processes and the supporting role of improved

transparency in achieving ethical principles. Wang et al. (2019) suggests that blockchain technology can eliminate intermediaries in asset transfer and customer removal.

Process Democratization - Blockchain provides the basis for democratic processes and can make corporate ownership a norm in the future (Manski, 2017). The division of services ensures that a high number of participants are directly involved in economic decision-making and that power is directly divided into the organization (Manski, 2017). This means that all users control all information and activities (Niranjanamurthy et al., 2018).

3.17.4 Building a Sustainable Supply Chain Series

A growing number of pressures on achieving sustainability goals are being addressed by governments, communities and consumers. Blockchain technology can assist companies in setting sustainable goals that they aspire to, and achieve (Saber, et al., 2018).

Selection of More Sustainable Suppliers - The desire for sustainable funding forces organizations to be more careful in their choice of suppliers, as the sustainability of the Supply chain is severely hampered by the activities of upstream suppliers. Procedures related to selection, testing and development providers can be improved with blockchain technology. Information is the main source of input into these processes. However, the accessibility and reliability of this information is often poor. Blockchain can enhance decision-making in these processes through the provision of high-quality data. In addition, smart contracts can help track what information was traded between suppliers and ensure that these suppliers are part of the supplier development plan. In addition, blockchain technology allows for the recording of information related to the investment costs of a supplier development program, vendor historical performance, and sustainability rates. This helps organizations judge suppliers based on their development after joining a development planner and allows companies to find providers who share the same sustainability values (Kouhizadeh and Sarkis, 2018). Finally, smart contracts can be used to independently track and regulate supply chain stability and automatically set action in case of cases (Saber et al., 2018). This may include standards like ISO 14001, which can be tested and updated whenever required (Kouhizadeh and Sarkis, 2018).

Waste Reduction in Storage - Storage operations can be stabilized through the distribution of blockchain-based solutions. Nowadays, suppliers of foreign companies have taken on many demands for storage. Often, different information systems are used, which creates difficulty in visibility. Blockchain can provide a clearer picture of these processes, improving trackability and order. This will lead to a lower amount of waste related to product loss. Waste minimization is a core goal of the supply chain. Wise contracts can play an important role in achieving this goal, as these contracts can include waste management agreements, operational

objectives, and metrics. Blockchain may also benefit from crowdsourcing, a shared economic concept that allows platform participants to respond to a request to perform a specific task. Blockchain can help democratize this process and transform the central, powerful position of service provider. This creates an environment for a very diverse group of participants, which can provide social sustainability benefits by incorporating groups from less privileged regions (Kouhizadeh and Sarkis, 2018).

Reducing Fuel Transport Consumption - Freight is a polluting activity. In the current system, drivers may be encouraged to drive faster and thus burn more fuel, in order to deliver on time. Blockchain can allow new promotions to be put in place, which can reward drivers for sustainable driving habits. Additionally, this may increase road safety (Kouhizadeh and Sarkis, 2018). Utilization of resources and emissions of greenhouse gases can be further reduced as product memory can be restricted and easy to accelerate, and because the formation of a blockchain system can reduce remote power transmission (Saber et al., 2018).

Round Economy - Casado-Vara et al. (2018) suggest that the supply chain in its current form adversely affects participant relationships, is not visible to customers in terms of product emergence and does not guarantee data reliability throughout the supply chain. They propose a separate model that includes transactions for all members of the supply chain stored on the blockchain.

Although the proposed model is related to a case study related to the agricultural supply chain, researchers say the proposed model could be used to improve any supply chain. The model consists of five layers, with an agent present in all layers. These agents are responsible for coordinating the various processes in the supply chain. There are stages of production, transportation, processing and sales related activities. Smart contracts are used to perform automated transactions between different layers. In addition, there is a blockchain agent synchronization in the blockchain layer with other agents that ensures adequate storage of transaction data. Researchers suggest that the adoption of this project will benefit the round economy, thanks to product tracking throughout their life cycle. Bensalem & Kin (2019) discusses the possible use of blockchain technology in Reverse Logistics. They predict that using a supply chain blockchain could be beneficial in tracking the full life cycle of components. The expected positive impact of this will be the improvement in market forecasts for recovered shares.

Increased Customer Interest - Consumers may be more motivated to buy environmentally friendly products if they are convinced that the product has gone through a completely raw production process. This is often complicated or impossible with current systems, however the blockchain can provide detailed, unambiguous information about the product life cycle (Saber et al., 2018). In the meantime, price estimates or frequently used to plan sustainability performance, while blockchain will allow the use of accurate, updated, and complete product data for analysis. This detailed product information helps to determine

whether sustainable revenue is incorporated, if the product is borrowed for recycling, and the amount of carbon dioxide emitted as a result of product production. (Kouhizadeh and Sarkis, 2018). A more accurate identification of the product's carbon footprint helps to determine the amount of carbon tax to be paid. Reconstruction systems can also gain a lot of power by integrating a blockchain. Consumers can be encouraged to reuse with cryptocurrency awards. Product information that is more explicit can lead to pressure from consumers or the market, which can lead firms to redesign their supply chains (Saber et al., 2018).

3.17.5 Improving the Stability of Supply Chain Series

Stability means the organisation's ability to survive, adapt and grow in times of dramatic change. The resilience of the supply chain is an addition to the risk management concept. Effective depletion management often involves the presence of a risk reduction list, with residual power. These are the costly and inefficient steps a blockchain can take with the recording of required data recovery and operations (Ivanov et al., 2018). Stability in the supply chain can benefit from improved blockchain visibility and new cloud computing systems. Improving supply chain visibility enables better robustness with improved predictive and adaptable skills. In addition, flexibility in filling processes can be improved by accessing real-time information driven by blockchain technology (Pettit et al., 2019).

Today's series networks often include trading partners scattered around the world. Business processes often conflict with these supply chains. Contracts are often the basis of supply chain processes, which is why it is important to prevent disputes when making commitments to these contracts. This complex supply chain combined with the major role played by contractors makes supply chains prone to disruption (Min, 2018).

Ivanov and Dolgui (2018) researched the concept of Low Certainty-Need (LCN) supply chain, a new way to manage the risk of supply chain disruption. This concept incorporates supply chain designs that do not require certainty about the environment and the changes in it. In the Need for Low-Demand supply chain, blockchain, as well as large-scale data analysis and sophisticated tracking systems, can help identify and monitor the impact of ripple and its impact on performance over time. In addition, it allows for the selection of short-term and medium-term recovery methods.

3.17.6 Supply Chain Finance

Caniato et al. (2019) cite big data statistics, blockchain, smart contracts, and Internet of Things as new technologies aimed at having a major impact on supply chain finance. The main reason for this is the existence of all transactions in a single public register, which establishes a clear and complete view. Various participants have access to the latest copy of shared records on the blockchain.

The following job description provides an easily identifiable track that can be used to track financial history (Niranjanamurthy et al., 2018). Second, extended authorization blocking the blockchain could be beneficial in providing chain financing through blockchain-based liabilities and factoring. Smart contracts allow financial transactions that can be automatically activated in the provision of a particular event. This includes physical physical synchronization with automated digital finance. This makes financial transactions in the supply chain faster and more efficient and provides solutions that include visibility and trust that are difficult to apply to current, non-blockchain systems (Caniato et al., 2019). This can be particularly helpful in the procurement process, which can contain large gaps in time between product delivery, invoice production and final payment (Kamble et al., 2018). In addition, corporate trust can be enhanced by sharing the risks and rewards that come with automatic payments after job verification (Min et al., 2019).

Procurement - Kamble et al. (2018) briefly describe the predictable role of blockchain technology in purchasing, which includes bringing digital confidence into the process where improved light is considered the most beneficial.

3.17.7 Data Quality and Security

High Quality Data - Hofmann and Rutschmann (2018) have decided that the blockchain will revolutionize data access and management. Blockchain can be seen as the first technology that allows you to track supply chain management information in real time (White, 2017).

Participant confidence - Another key benefit of improved data security is the high level of confidence and confidence that supply chain participants have in the operations. Supply chain data in the blockchain is consistent and secure and all existing organizations have access to the same information (Wang et al, 2018). Blockchain can improve the flow of information, assets and funds between an organization and its providers, as well as the flow of provider and manufacturer to the customer. Therefore, it can be most accurately determined when insecurity in the supply chain arises. The ability to manage personal data is provided to users with blockchain technology. Accountability is individual and easy to assign to the team, which means that conflicts are less likely to arise. In today's supply chain, it is often difficult to find device owners and inform them of security violations. With blockchain, users of IoT devices that display risks can be identified by linking activities (Kshetri, 2017b). As the size of the network grows rapidly, the extended design of the blockchain system ensures a secure path (Kshetri, 2017b).

Dishonest Activity - Expiration of efforts initiated to improve trust between the parties may arise because of transparency and consistency of shared data. This means a change in the value and characteristics of the relationship between the participants of the supply chain. Blockchain can facilitate communication between

previously banned companies and provide a reliable flow of information (Treiblmaier, 2018). Cole et al., (2019) suggest that the blockchain provides confidence in the operation of the supply chain through full transparency, but that does not mean that firms trust each other. After all, the introduction of blockchain technology was unthinkable following the occurrence of reckless behavior that undermines trust.

3.17.8 Processes Automation

Smart contracts can be a blockchain application that transforms supply chains too (Wang et al., 2019). They can be the cause of continuous improvement of supply chain business processes. Performance metrics can be taken with blockchain technology, which can be linked to process improvements. This is set to have a major impact on the construction of the supply chain (Sabeti et al., 2018). Encouraged smart contracts, transactions can be accelerated by automation (Niranjanamurthy et al., 2018). The process speed can be improved by digitizing and reducing the amount of communication and communication currently required for the process to be successful (Kshetri, 2017a). Blockchain allows for continuous processing of transactions at any time of the day, making it much faster than transactions between banks and other organizations, which can take a few days to complete (Niranjanamurthy et al., 2018).

Smart contracts can allow for automatic revision of records, thus providing a real-time perspective on when goods are purchased, sold and delivered. (Sabeti et al., 2018). Blockchain-based solutions allow for full digital integration of shipping container documents, eliminating the need for portable paper and manual processing (Kshetri, 2017a). Verification of production limits can be done automatically on a large scale with smart contracts. 3D printing can also benefit from blockchain technology, namely the development of design and attributes (Kamble et al., 2018).

Additionally, the automation of certification processes can be simplified in the supply chain (Kshetri, 2017a). In addition, the blockchain can facilitate a high level of security and speed of action by having a set book. By giving other organizations access to this ladder, the process of proving identity can be greatly reduced in length (Maull et al., 2017).

Xu et al. (2019) has worked on a project that involves the inclusion of smart contracts in a tracking system. In this program, providers submit a web form in which the desired tracking resources are displayed. The submission of this form calls for a so-called factory contract, which contains many contract templates with a different tracking service combination and automatically ensures that the relevant information required for compliance is provided. The use of a factory contract is seen as a flexible and secure way to build smart contracts. Three different smart contracts are created when a factory contract is made: a registration contract linked to a legal contract, a service contract, and a data contract.

Digitalization - Blockchain can also support digital media management. This is guided by a real-time recording of activity in a shared book. Supply chain digitalization is considered to be very useful in international supply chains with many stakeholders. This digital inclusion can help improve the flow of goods in a supply chain (Wang et al., 2018).

Cost-Consuming - Verification is a process that requires a lot of resources in many modern chains. Blockchain can significantly reduce the number of resources required for this process. Demonstrating this development is particularly important in a supply chain where recorded activity is often shared with the aim of improving collaboration, collaboration, and quality of services (Min et al., 2019).

Operating costs are significantly reduced due to the removal of mediators and higher exchange costs (Niranjanamurthy et al., 2018). Treiblmaier (2018) predicts that incorporating blockchain technology could lead to a reduction in internal and external transaction costs. In addition, costs are saved as junior staff should be monitored for website management and there is a reduced need to develop processes to combat information interference (Niranjanamurthy et al., 2018).

4 Practical Part

This chapter presents the results of the analysis and provides a bridge from the theoretical background needed to understand the results, to the findings of the actual study. The analysis process described earlier begins briefly. The data in this category matrix is divided into a few different categories, to provide a more complete view and facilitate the development of a clear model.

Quality analysis has been done through systematic interviews with people who work or have experience in the blockchain field as well as having relevant knowledge about the same implementation in the supply chain. In total, 25 interviews were conducted via e-mail and in them, 20 interviews were considered in the study as they were the only completed ones with answers to all the questions.

4.1 Research Questions

What kind of opportunities exists for blockchain solutions in supply chain?

What are the limitations for the blockchain technology in supply chain?

What is the impact of blockchain on the relationship between supply chain partners during and after the implementation?

4.2 Interview Questionnaire

1. Your Full Name
2. What is your current role in your company? To what extent are you involved with supply chain or IT?
3. Are you aware of blockchain technology? Was it implemented in your organization? How was it implemented? If not, why?
4. Describe current and foreseeable issues in the supply chain in your organization?
5. To what extent do you think issues described earlier can be mitigated by implementing blockchain solutions?
6. What could be prerequisites and preconditions for the implementation of Blockchain technology in your organization?
7. What can be prominent drivers for enabling blockchain in the supply chain?
8. What can be the major limitations that prevent the implementation of blockchain in the supply chain?
9. Any additional comments

Table 1 - Interviewed Respondent Details

Name	Current Position
------	------------------

Arjun Kalia	Sourcing & Supply Chain Manager-SAARC division
Anup Chhokar	Sales Associate - TATA STEEL, partially involved as managing coordination between production plants and warehouses.
Jayaraj Arokiyasamy	Head of IT, Fully Involved in both Functions.
Meet Parikh	I am a Project Manager in IT product-based company. I have an experience involved in Supply Chain process
Jyoti Tauro	Senior Financial Analyst. Have some knowledge on blockchain with supply chain
Rishabh Mudgal	Product Lead - Middle and Last Mile (80-90% involved)
Shrey Gera	Packaging engineer. Handling inventory needed for the assembly line
Rutvij Vaishnav	Owner. Completely involved from sourcing to supplying.
Nishant Patel	Sr. Machine Learning scientist. Our business revolves around supply chain tracking using IOT sensors.
Het Vyas	Project Manager and Marketing Executive
Darshit Shah	I work as a supply chain strategy consultant to advise clients to improve their supply chains. I am completely involved with the supply chain and to some extent technology fields.
Sohaib Sulaiman	Area Sales Manager. I have regular coordination with supply chain team to ensure local availability of products
Goutham Ravichandiran	UX designer
Manik Vig	Capacity Planning in Supply Chain
Pratik Patil	I am currently an MBA student at NITIE Mumbai, for Operations/Supply Chain Management domain.
Jayraj Trivedi	Working as an IT consultant. Does not involve supply chain but involves IT
Erik Valiquette	CEO of the Blockchain Supply Chain Association
Kevin Bao	CEO, 100% in both
Sujar Jacob	Distribution Center Management & Projects
Anisha Goel	I'm IT Project Manager in Cisco. My work mainly involves IT and about 20% supply chain management.

Table 1

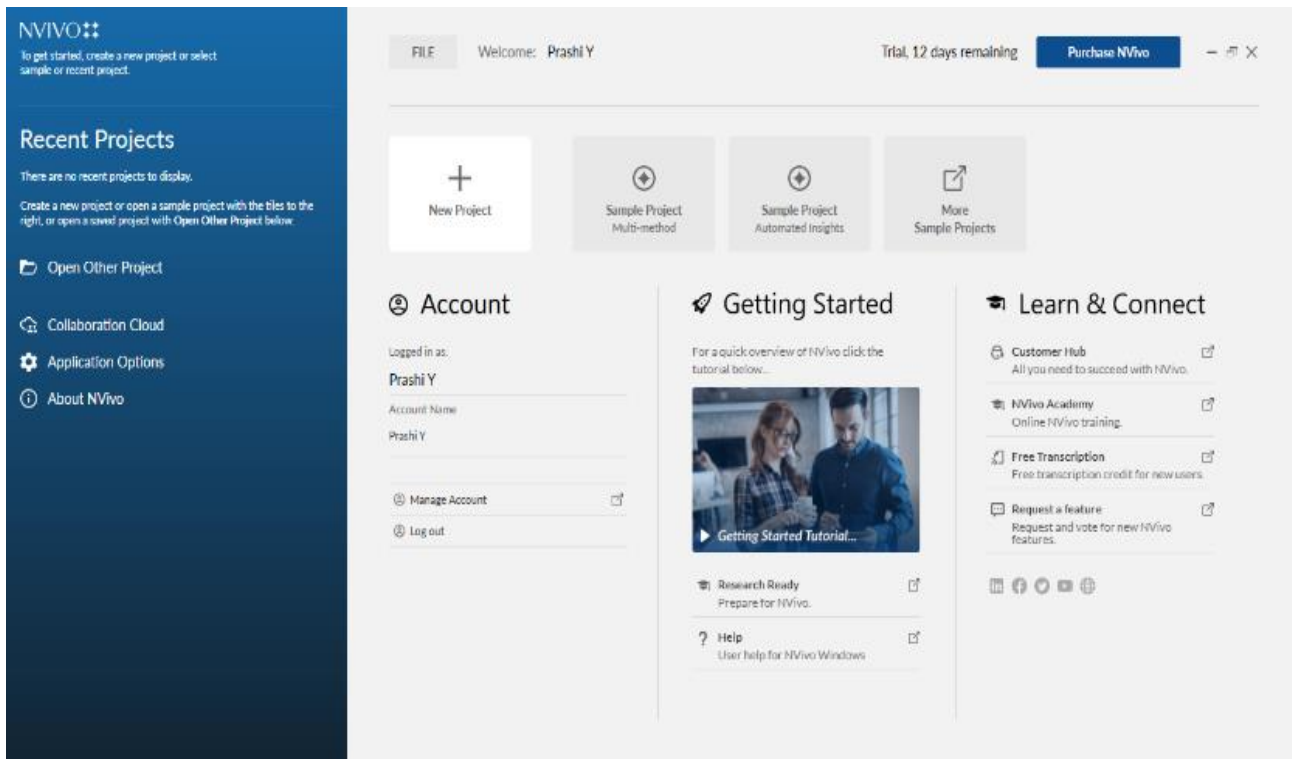
As explained in literature review section, the Beamon Categorization (1999) is used for this study to understand the impact of blockchain implication on supply chain performance. The three performance measurement categories that are proposed in that paper are (1) Resources, (2) Output, and (3) Flexibility.

The collected interviews have been coded in the Nvivo Software to identify the themes based on the statements. Along with that, some themes have been found by the literature reviews as well. Those themes will be the clear base for classifying the various subcategories under the three main categories. This will be the factors that affects the supply chain performance after implementing the blockchain.

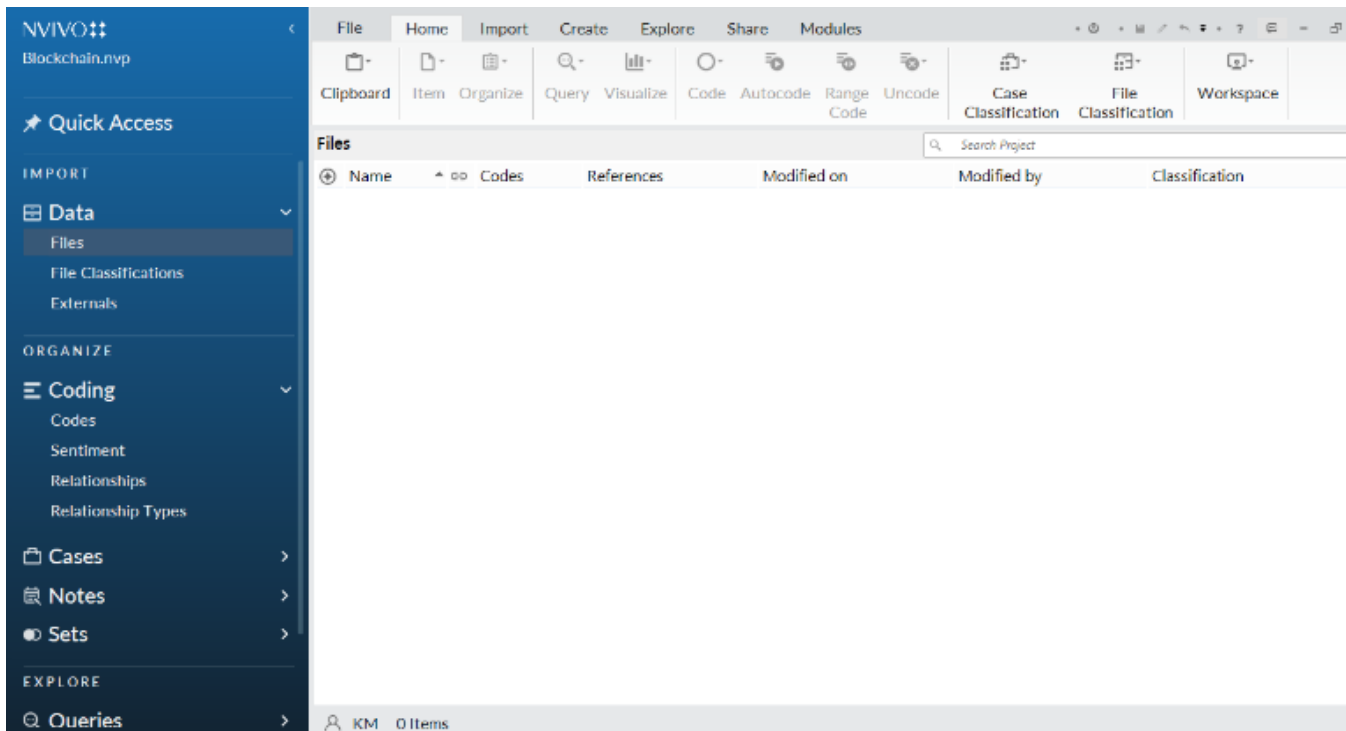
4.3 NVivo Software

For analytical purposes, NVivo Software has been used and the same step-by-step process is described below. NVivo is a software program used for high-tech and mixed-language research. Specifically, it is used to analyse unorganized text, audio, video, and image data, including (but not limited to) interviews, focus groups, surveys, social media, and journal articles. Produced by QSR International. As this is the qualitative study, for the purpose of narrative analysis NVivo software perfectly matches the requirement.

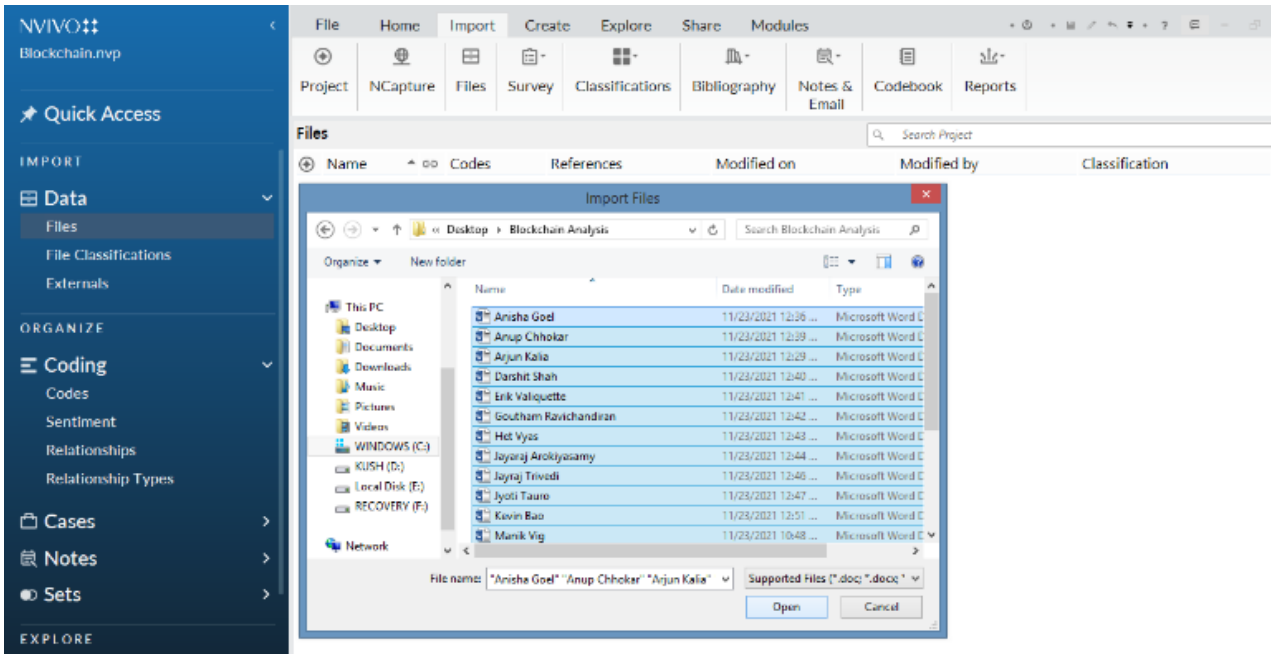
Picture 1 - NVivo Software Home Screen



Picture 2 - NVivo Software Dashboard

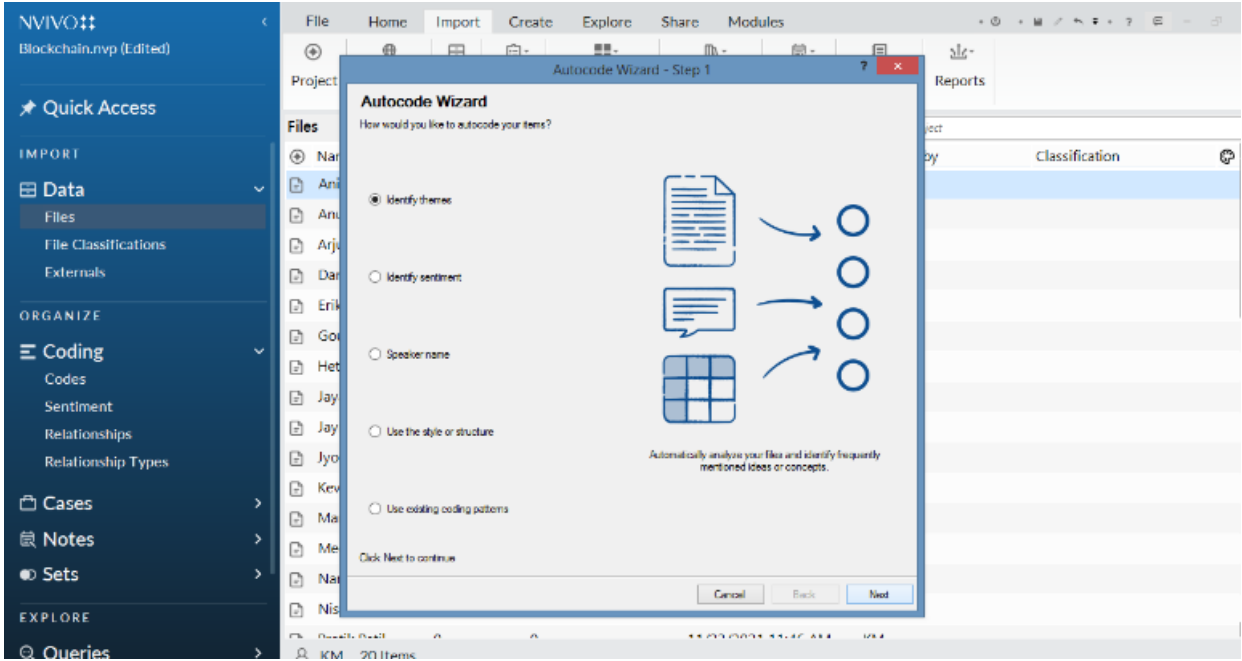


Picture 3 - NVivo Software Import Files



To start the analysis, the first step is to import all the interview files in the software. This were the Word Documents containing the unstructured text data of the selected interviews.

Picture 4 - NVivo Software Auto code Wizard



The next important step is to code the interview files and for the ease of work, the auto code feature has been used. For this, any of the multiple options can be selected to identify theme, sentiment or style. For this study, theme was the basic component for the analysis.

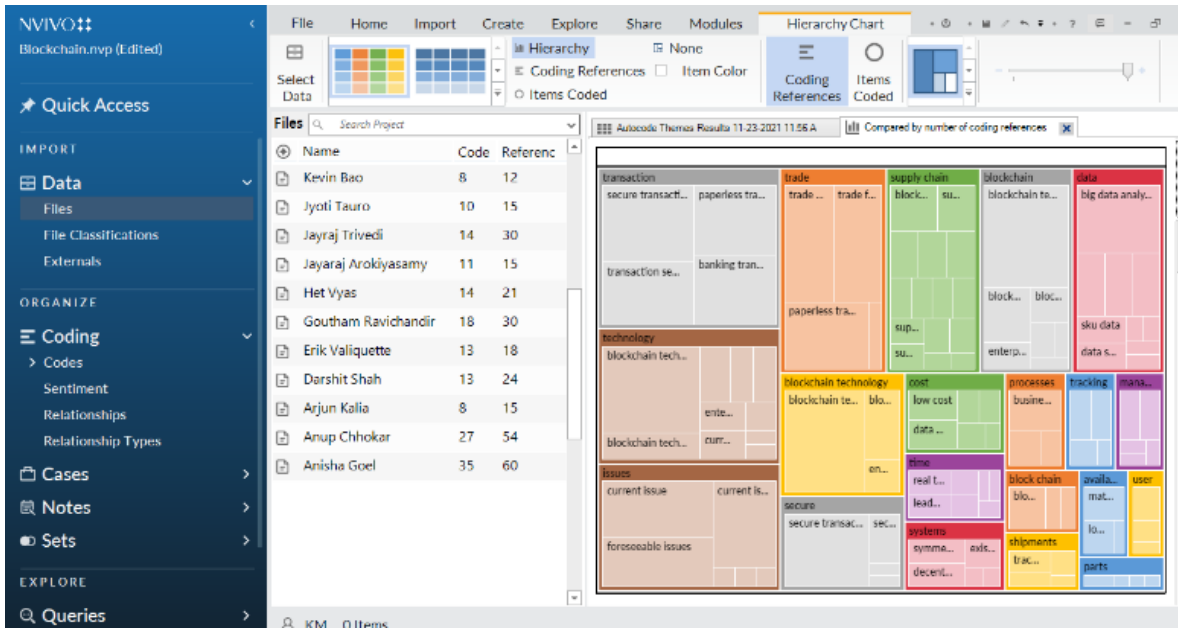
Picture 5 - NVivo Software Coding Data

The screenshot shows the NVIVO software interface. On the left is a sidebar with navigation options: Quick Access, Data (Files, File Classifications, Externals), ORGANIZE, Coding (Codes, Sentiment, Relationships, Relationship Types), Cases, Notes, Sets, EXPLORE, and Queries. The main window is titled 'Blockchain.nvp (Edited)' and has a menu bar with File, Home, Import, Create, Explore, Share, Modules, and Matrix. Below the menu bar are tabs for Coding References, Files Coded, Cases Coded, Row Percentage, Column Percentage, Coding Presence, Duration Coded, and Words Coded. The Matrix view shows 'Autocode Themes Results 11-23-2021 11:56 A' compared by number of items coded. It features a 'Files' list on the left and a matrix on the right. The matrix has columns for themes A, B, C, and D, and rows for 20 files. The status bar at the bottom shows 'KM 110 Items' and 'Cell content: Coding references count'.

Files	A: availability	B: block chain	C: blockchain	D: blockch
1: Files/Anisha Goel	0	0	1	0
2: Files/Anup Chhokar	0	0	1	0
3: Files/Arjun Kalia	2	0	0	0
4: Files/Darshit Shah	0	0	0	0
5: Files/Erik Valiquette	0	0	0	0
6: Files/Goutham Ravich...	1	0	0	0
7: Files/Het Vyas	0	0	2	0
8: Files/Jayraj Arokiyas...	0	1	0	0
9: Files/Jayraj Trivedi	0	0	2	0
10: Files/Jyoti Tauro	0	0	0	0
11: Files/Kevin Bao	0	0	0	0
12: Files/Manik Ma	0	0	0	0
13: Files/Meet Parikh	0	0	0	0
14: Files/Naren Mahajan	0	1	0	0
15: Files/Nishant Patel	0	1	2	0
16: Files/Pratik Patil	0	0	1	0
17: Files/Rutvij Vaishnar	0	1	0	0
18: Files/Shrey Gera	0	0	0	0
19: Files/Shaab Sulaiman	2	0	0	0
20: Files/Sujan Jacob	0	0	1	0

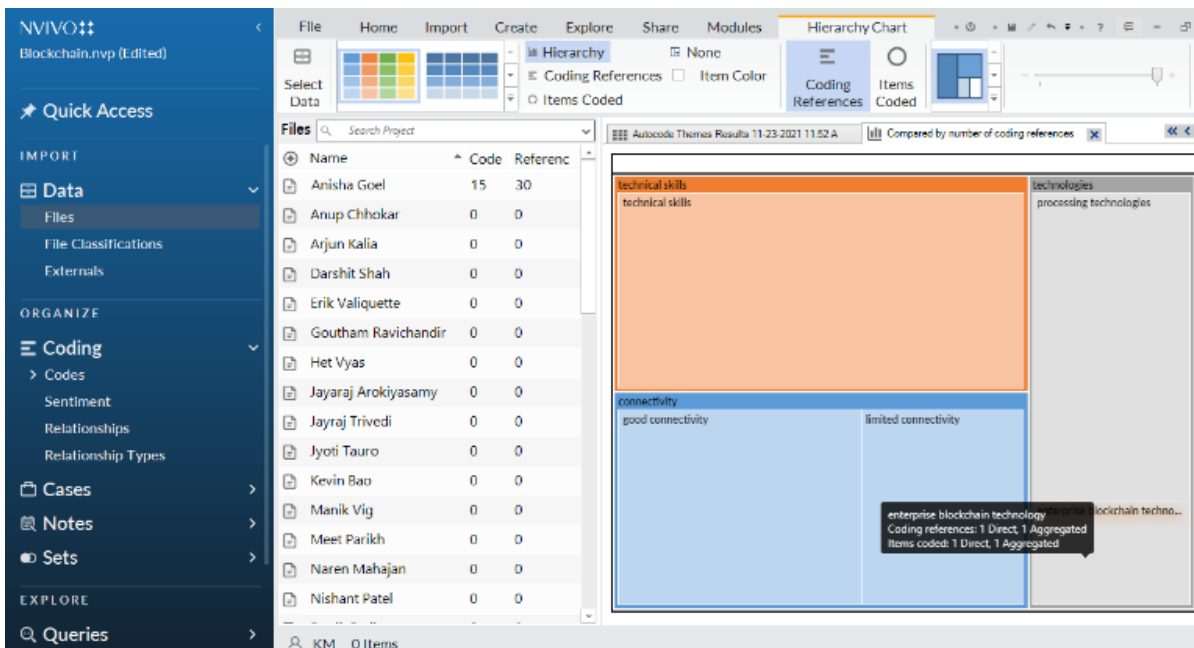
The coding data enables with the identifying the themes from the selected interviews and this same will be used further for the categorization.

Picture 6 - NVivo Software Coding References



The coding references are used to analyse the different themes based on statements derived from the selected interviews and in next part it has been explained in detail.

Picture 7 - NVivo Software Automated Themes



These are some of major automated themes derived from the analysis using the software. This will give way to develop more pathways.

4.3.1 Resource Category

I. Costs

Statements - High Operating Costs, Increasing Mining Costs, High Operating Costs, Reducing Operating Costs, Reducing Product Management Costs

Description - The Cost subcategory contains all data relating to the increase or decrease in supply chain costs resulting from the deployment of blockchain technology.

II. Efficiency

Statements - Improving efficiency, improving efficiency, improving payment efficiency, reducing the need for verification, reducing waste

Description - Performance is a very common clause, consisting of mixed entries about blockchain effects in all and process efficiency.

III. Energy

Statements - Increasing Power Consumption

Description - The lower power category includes data related to the effects on potential use of blockchain technology that they may have.

IV. Information

Statements - Improving Information Response Speed, Improving Risk Analysis Information, Improving Access to Security Information, Improving Security Management Information

Description - The sub-category of information focuses on the two-dimensional flow of information relevant to the supply chain.

V. Processes

Statements - Improving Needs Forecasting, Improving Resource Utilization, Improving Income Processes, Improving Property Management, Improving Ethics and Coordination

Description - The sub-section of the process contains ideas on process development and impacts on process risks.

VI. Time

Statements - Increased Real Estate Flow, Increase Monetization, Slow Performance Verification

Description - This sub-section includes data on the effects of blockchain on improving or harming the speed of processes.

VII. Visibility

Statements - Improving Readability, Improving Product Tracking, Improving Problem Tracking, Improving Product Tracking, Increasing Transparency

Description - Appearance incorporates the performance effects derived from the blockchain capabilities that create a more open space for the supply chain.

4.3.2 Output Category

I. Branding

Statements - Increasing Consumer Risk Vision, Improving Consumer Confidence, Improving Consumer Commitment, Improving Product Reliability, Increasing Product Sales

Description - The sub-category of product includes effects on consumer product vision, resulting in the deployment of blockchain-based solutions to the supply chain.

II. Innovation

Statements - Enabling Advanced Innovation, Promoting New Market Opportunities, Increasing Customization, Introducing New Products

Description - Innovation is a sub-category that incorporates new opportunities on the exit side, an organization capable of creating a blockchain supply chain.

III. Output Quality

Statements - Compliance with Quality, Compliance with Security Standards, Improving Product Quality, Improving Service Quality

Description - Output quality refers to the potential blockchain effects on the quality of the final product or service delivery.

4.3.3 Flexibility Category

I. Logistics

Statements - Improving Flexibility

Description - At this stage, the predicted blockchain effects on the flexibility of logistics processes are collected.

II. Prevention

Statements - Improving Awareness Skills, System Performance, Reducing the Risk of Disruption of the Supply Chain, Improving System Security, Reducing the Risk of Disruption of Information

Description - Blocking includes data related to blockchain opportunities provided to prevent events that could disrupt performance.

III. Resilience

Statements - Improving Emergency Planning, Improving Asset Management Flexibility, Developing Practical Skills, Effective Event Identification, Effective Event Response

Description - The Strengthening Stage component includes blockchain power data to assist or damage organizational flexibility in times when rapid change is required to ensure that performance is not compromised.

5 Results and Discussion

5.1 Results

Table 2 – Coding references in NVivo

Name	Code	Reference
Kevin Bao	8	12
Jyoti Tauro	10	15
Jayaraj Arokiyasamy	11	15
Erik Valiquette	13	18
Anisha Goel	35	60
Arjun Kalia	8	15
Darshit Shah	13	24
Jayaraj Trivedi	14	30
Anup Chhokar	27	54
Het Vyas	14	21
Goutham Ravichandir	18	30

Reference – count of times a particular node was mentioned by the participants/respondents/cases

5.2 Discussion

The current section of the results focuses on the retrieval of analysed data from interviews and literature reviews and presents them based on various research objectives. This section describes the pros and cons of blockchain in the supply chain based on current research to evaluate opportunities and limitations as stated in the research objectives. There were 3 research questions for this study and this discussion will lead to the same answers.

5.2.1 Current use of blockchain within supply chain-oriented enterprise

Research Objective 1 Throughout the review, it became clear that most blockchain solutions were designed for the agricultural and food industry. However, the pharmaceutical and various sectors are also important. Considering the conditions of use, most solutions are aimed at tracking and tracking products or preventing fraud. This is also reflected in solved challenges, as problems of information asymmetry and anonymous emergence were frequently mentioned.

With regards to input data collection methods, the Internet of Things devices are often proposed to address the real-time transparency of product information, and staff input relies heavily on it. The level of data entry in blockchain systems has not been adequately addressed in current literature as it is considered an important part of the papers that do not address the use or need for data integrity processes. Instead, academics focus more on data security and stability when it comes to blockchain itself. One area of concern is relying on

trustworthy third parties to ensure data integrity as this can be bottled and allow unscrupulous actors to insert bad data into a blockchain solution. (Wang et al, 2018)

Overall, the proposed solutions are in the metric testing phase, and many have not yet implemented the proposed systems and firms. With regards to supply chain management systems supported, supply chain management processes involving several supply chain groups were rarely addressed. This includes product development and marketing; customer relationship management; and reimbursement management. Although ignored, the return management process may allow for further testing because of its role in identifying product development opportunities. (Kshetri, 2017b)

Research Question 1 - What kind of opportunities exists for blockchain solutions in supply chain?

Blockchain is predicted to provide supply chain management with many positive performance results. Improved performance is often cited as an advantage of blockchain performance. Many sources speak of general benefits of efficiency, while others provide detailed information. It has been suggested that the blockchain can increase efficiency in a variety of processes: efficiency, payment efficiency, efficiency in planning and planning, and efficient trading processes. In addition, technology can be used to reduce waste and thus utilize resources efficiently.

In addition to the benefits of efficiency, the blockchain is set to improve the performance of the supply chain process in other ways. Co-ordination of supply chain, demand forecasting, incoming processes, and certification and product registration processes have been identified as areas where renaming can have a positive impact on performance. In addition, the number of errors in processes can be reduced. In addition, procedures can be set up with ethics, fraud can be prevented, and corruption can be curtailed.

Blockchain is also praised for its cost-cutting ability. Technological features allow for cost reduction in many areas. Blockchain helps reduce costs in building trust, product tracking, inventory management, risk reduction, and monitoring processes. Blockchain-induced Disintermediation reduces negotiation and transaction costs. Improved processing performance reduces costs of verification, transportation and transportation, and overall operations. This also causes an increase in the speed at which the transaction is processed, as well as the speed of physical movement of goods.

Information is a tool where the blockchain can offer great benefits in terms of improving availability. Clearly, this goes hand in hand with the availability of risk analysis information, safety information, and safety management information. The Blockchain feature of providing high level of visibility throughout the supply chain can improve auditing, inventory tracking, problem tracking, product tracking, and improve transparency in processes.

5.2.2 Potential opportunities of blockchain in supply chain-oriented enterprise

Research Objective 2 - Opportunities of Blockchain Implementation

Transparency

Blockchain is a shared website that promotes credible visibility. All partners are responsible for uploading their information and data about the product. An accurate digital data collection enhances accountability and trust between partners. Blockchain technology can display product updates in minutes. The seller can now determine how many products are available, when they will arrive, and how they will be delivered. Blockchain builds relationships between partners. This creates a systematic process with shorter lead times, reduced reuse, fewer delays, and ultimately a series of smaller service providers. (Treiblmaier, 2018)

Security

Blockchain tech is made up of secure “blocks”. These copies of the document are stored in chronological order and linked to previous blocks. This makes them more secure and more challenging to lie. The hacker will have to convert hundreds of copies at once, which is not possible unless the software downloads it. This is what makes blockchain the technology used by Bitcoin and the major financial services and banks. If you want to make sure your supply chain data is constantly being monitored for cyber-attacks (which are very common these days), blockchain is a viable solution. (Maull et al., 2017)

Tasks

All information is uploaded to the cloud. This digital input leads to less administrative work and consistent data tracking. You do not have to try to contact your partners to get the information you need; you sign in to the blockchain to download that information immediately. Everything about the product is in one place, making communication and operation much easier. Moreover, the blockchain is global and growing. This means that technology can support global cooperation and communication in just minutes. This makes it a viable solution to the global trade economy. (Swan, 2015)

Statistics - Blockchain is more than just storage technology. Provides complex solutions for analysing uploaded data. It can help create predictions and predictions based on previous data and can allow users to identify supply chain lags. These data figures appear to be useful to companies looking to reduce supply chain costs and grow their businesses.

Customer Interaction

Those statistics can also be used to increase customer satisfaction. Vendors can use a blockchain database to see when items are being produced and shipped to better build their store's delivery timeline. In addition, customers can also access certain data in the blockchain. For example, a clothing brand dedicated to fighting

sweatshops might give their customers access to the blockchain, show them a public awareness form, a trade union sheet, and a laundry guide. This type of data sharing creates a new level of transparency for the consumer in a way that builds deep and trusting customer relationships. (Gilbert, 2016)

5.2.3 Challenges of Blockchain Implementation in supply chain management

The Blockchain system is complex and challenging. Companies should hold comprehensive blockchain training or third-party programs to ensure that they are properly organized. Blockchain is international, which means it obeys various laws of the land. This can be a challenge for international companies to manage. Going forward, we expect trade associations to better balance the use of the supply chain blockchain. Blockchain depends on the outcome of the network. The more people use it, the more valuable it becomes. To be truly effective, all supply chain partners must use the platform consistently. Currently, not all businesses use blockchain. However, we expect it to grow in popularity as larger organizations continue to use this technology in their programs. (Williams et al., 2015)

Research Question 2 - What are the limitations for the blockchain technology in supply chain?

While the blockchain offers many good results for processes and resources, key issues also exist in this area. There are concerns about the cost of implementing blockchain technology and the cost of mining operations required to secure transactions. In addition, the amount of power the blockchain-based supply chain network is designed to use is seen as a potential challenge to the company's performance. Lastly, some transactions can take longer to process in a centralized web system.

When it comes to output, blockchain may increase consumer risk perceptions. This is a potential problem when the extended visibility provided by the blockchain is used to provide more unwanted and potentially blocking information. This can make consumers less inclined to make a purchase decision, thus having a negative effect on sales. No potential adverse effects associated with conformity are identified.

The main research objective of this study was described as "Providing a clear view of the potential impact of blockchain technology on the supply chain". Using the results of the content analysis process, a model with this purpose was created.

5.2.4 Impact of blockchain implementation on supply chain management

Research objective 3

Throughout their operations, companies first try to plan how to deal with uncertainty and risks. Moreover, they are aware of new opportunities that they can seize, thanks to their knowledge. Businesses can adjust

their operating cycles to high volatility in the market in anticipation of the worst they can face and take the fastest way to earn a competitive advantage and maintain their presence in this way. (Christopher, 2015)

Therefore, it is an indisputable fact that knowledge is essential to business. At this point, blockchain technology is seen as an opportunity to process data and information, which is one of the most important assets of companies, effectively, and to maintain them in a secure security system with reduced costs. The fact that connectivity has increased significantly due to digital technology can improve collaboration and integration into supply chains. It is also a different matter to protect this commitment from malicious programs. (Crosby et al., 2016, 8)

In this context, the idea that blockchain technology could benefit companies motivated us to do the research. In this study, we wanted to investigate how transparency, flexibility, and trust, which are among the key requirements for making the most effective process of supply chain, will affect the new information technology. We anticipate that these changes will increase the level of cooperation and integration in supply chains. The more supply chain participants can trust, the more information they can share, the more information they share, the more transparent supply chain can be obtained, and better integration can be achieved. The level of cooperation can increase, and thus the flexibility of the supply chain can increase. (Lieber, 2017)

In this study, the impact of the use of blockchain technology on supply chain flexibility, transparency, and reliability has been investigated. Blockchain technology is approaching suspicious because it is very new and unknown to companies. Therefore, companies may view their investment in these technologies as high risk. In this study, we have tried to identify some of the technological benefits in question that companies can offer. To this end, we have decided to put things beyond, flexibility, and trust, which are key issues in supply chains, such as research-based diversity. (Kakavand et al., 2016)

Blockchain deployment in the supply chain offers a significant amount of performance benefits down to the supply chain. It can enhance the confidence and confidence that people have in the product, improve the credibility of the organization, and reduce the perceptions of potential consumer risks. Ultimately, this can make consumers more willing to buy the product, thus increasing sales.

In terms of innovation, blockchain technology can aid in the provision of new products, a growing number of customization options, and the establishment of sustainability. Finally, new markets can be addressed through the distribution of technology in supply chain management. Supply chain supply rate can be greatly improved with blockchain technology. As technology helps ensure compliance with safety and quality standards, your quality of both services and products can be improved, customer requests can be cared for in a timely manner, and lead times can be reduced. The amount of delayed and damaged goods can be reduced,

and the amount of product return can be predicted more accurately. All these influences mean performance improvements in terms of reliability.

In terms of flexibility in logistics processes, implementation is a process in which the blockchain can offer a significant amount of performance enhancements. Another area where the blockchain can play a major role is to prevent interruptions from happening and to be better protected from them if they happen. Blockchain empowers performance enhancements in the area by improving the ability to anticipate these types of events, improving the quality of implementation of an emergency plan, and reducing risks to information disruption, time, and provision. All of this leads to a much safer supply chain.

In the event of disruptive events, blockchain integration into supply chain processes can have a positive impact on resilience efforts and reduce the impact of disruption. Technology can enable greater flexibility in managing these events. Emergency planning procedures can be improved, and adaptability can be improved. Finally, events can be identified and responded to with the greatest effect. (Ivanov et al., 2017)

Research Question 3 - What is the impact of blockchain on the relationship between supply chain partners during and after the implementation?

Blockchain is an exciting technology that offers a wealth of research areas in a variety of fields, including computer science, engineering, finance, and supply chain management. Although the number of publications related to blockchain-related topics is growing and moving from conventional definitions to other specific applications, there is still much work to be done to help the technology reach the potential that so many think it has. This section contains the study areas found in this study that may be of interest to other researchers.

First, the performance results identified in this study are not always directly related to tangible applications or deployment strategies. It can be said that the blockchain shows great potential to improve performance in certain areas. However, the text does not always explicitly state how this is done. Therefore, it is necessary for future publications to provide a clear link between the applications on the one hand and the impact based on the performance of the supply chain on the other. Specifically, a research project specific to this topic may be introduced, in which additional practical interaction is made between applications and performance outcomes. This can be conveyed in the same way as the combined results presented in this thesis.

This recommendation is in line with the original recommendation. In addition to connecting applications with performance results that have already been identified, research can focus on capturing the blockchain system and finding out how it affects performance. This can help create a more complete and complete view of all the potential blockchain impacts on supply chains. For example, one can look at blockchain requests to determine product availability and research how blockchain deployments for that purpose affect performance.

Another finding in content analysis is that current literature does not explain the results of performance in detail. Claims are made as to 'blockchain shipments increased supply chain visibility' and 'transaction costs decrease by adopting blockchain technology'. However, it is not specified what level of reflection is achieved, or what the perceived reduction in transaction costs is. This could be a case of not getting enough data due to the emergence of technology. However, highly specific data on performance results, possibly quantitative data, can add a significant amount.

Numerical performance results may encourage managers to opt for blockchain deployments in their supply chain, thereby increasing the speed of distribution in the supply chain management sector. In addition, it may encourage more supply chain stakeholders to join, which is important considering that a large portion of the blockchain value is derived from a complete supply chain across the board.

Surprising findings from the analysis were significant differences between the number of positive and negative outcomes obtained. Whether this is due to a lack of knowledge, a lack of research interest, or because blockchain can be a technology that does not have many negative consequences, this area needs more research. A research project in which the negative effects of the blockchain on supply chain performance are well defined could provide a purposeful and balanced view or conclude that the blockchain does not produce many negative effects. Either way, this can bring great value to this field of research.

Another recommendation would be to do an analysis of the same content, but to use a method that combines different categories. Additionally, a teaching method may be adopted from the outset, considering the specific area of study. This can provide the most appropriate framework as a reference point for specific employees or managers, depending on research interests, business sector, and performance measurement.

Another feature of this study was that it was not able to determine the timing of performance results. Due to insufficient information, this long life could not be established. Where possible, a different approach to research could be taken to determine whether impacts could affect short-term or long-term supply chains.

6 Conclusion

The purpose of this thesis was to understand the current use of blockchain in supply chain as well as implementation related benefits & challenges for the same. The purpose was divided into three research questions on which the whole study was based. To achieve the purpose of the research, the following research questions were answered within the analysis phase.

In the reference framework, transparency and compliance have been identified as important benefits of ensuring social and environmental processes. High-value tracking has been used in a variety of luxury industries, from wine to luxury diamonds and watches, to prove the authenticity of premium products. By reducing blockchain barriers, it can be used not only to combat fraud, but also to measure the environmental and social impact of consumer products. Reducing implementation costs will make it easier for companies of all sizes to use the blockchain to ensure sustainable processes.

Current acquisition barriers are divided into four sections in the reference framework. The four sectors were: internal, supply chain, technology and external. Using empirical data, our aim was to obtain data from various industries. The most common barriers were collected from the active data and shown in Figure 11 in the analysis. Major Blockchain barriers to SSCM include lack of resources, lack of knowledge, collaboration and connectivity issues, technical barriers due to IT infrastructure needs, and lack of government regulations.

About the above-mentioned barriers, four real-time challenges for consumer product companies are identified: reliable information, location range, supply chain complexity, and tracking. Product tracking is done with certificates and audits, but companies cannot fully guarantee that suppliers are as stable as they claim to be. These problems are exacerbated by the growing complexity of supply chains around the world. As a non-convertible distributed book, blockchain can be the solution to this problem.

Theoretical implications - Research has influenced current literature by investigating the potential of the blockchain to produce a testable supply chain from a sustainability perspective. Recent research is in the testing phase when it comes to blockchain adoption in supply chain management. However, there is a lack of practical research on the topic of how theory is reflected in the business environment. Thanks to an additional research approach, key barriers and benefits have been identified both from theoretical and empirical data when it comes to using blockchain technology in supply chain management.

Managerial implications - Research aligned blockchain capabilities to transform supply chain management through transparency and tracking. The findings of the study underscore certain aspects of blockchain technology that can manage the complexity of supply chains around the world. Blockchain is still an emerging technology, but research has shown hope for using technology beyond the financial sector. This research helps companies and executives understand the power of blockchain technology in terms of sustainability.

Future scope - As an emerging technology, blockchain understanding has not yet been fully developed. In addition, the lack of blockchain terminology makes it difficult to communicate between different stakeholders. There needs to be an active look at certain blockchain attributes and their implications for supply chain management. Finally, as mentioned in the study, many firms are hesitant to invest in blockchain technology due to ignorance of costs. Therefore, future research should conduct an in-depth analysis of the cost of blockchain implementation using the entire supply chain. This will provide important parameters for potential companies to be considered.

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8 Appendix

Appendix 1: Table of Interviewees

Appendix 2: Questionnaire

Appendix 3: Interview Transcripts

Appendix 4: Results of code references of NVivo

Appendix 1: Table of Interviewees

Name	Current Position
Arjun Kalia	Sourcing & Supply Chain Manager-SAARC division
Anup Chhokar	Sales Associate - TATA STEEL, partially involved as managing coordination between production plants and warehouses.
Jayaraj Arokiyasamy	Head of IT, Fully Involved in both Functions.
Meet Parikh	I am a Project Manager in IT product-based company. I have an experience involved in Supply Chain process
Jyoti Tauro	Senior Financial Analyst. Have some knowledge on blockchain with supply chain
Rishabh Mudgal	Product Lead - Middle and Last Mile (80-90% involved)
Shrey Gera	Packaging engineer. Handling inventory needed for the assembly line
Rutvij Vaishnav	Owner. Completely involved from sourcing to supplying.
Nishant Patel	Sr. Machine Learning scientist. Our business revolves around supply chain tracking using IOT sensors.
Het Vyas	Project Manager and Marketing Executive
Darshit Shah	I work as a supply chain strategy consultant to advise clients to improve their supply chains. I am completely involved with the supply chain and to some extent technology fields.
Sohaib Sulaiman	Area Sales Manager. I have regular coordination with supply chain team to ensure local availability of products
Goutham Ravichandiran	UX designer
Manik Vig	Capacity Planning in Supply Chain
Pratik Patil	I am currently an MBA student at NITIE Mumbai, for Operations/Supply Chain Management domain.
Jayraj Trivedi	Working as an IT consultant. Does not involve supply chain but involves IT
Erik Valiquette	CEO of the Blockchain Supply Chain Association
Kevin Bao	CEO, 100% in both
Sujar Jacob	Distribution Center Management & Projects
Anisha Goel	I'm IT Project Manager in Cisco. My work mainly involves IT and about 20% supply chain management.

Appendix 2: Questionnaire

Interview Questionnaire

- [1] Your Full Name
- [2] What is your current role in your company? To what extent are you involved with supply chain or IT?
- [3] Are you aware of blockchain technology? Was it implemented in your organization? How was it implemented? If not, why?
- [4] Describe current and foreseeable issues in the supply chain in your organization?
- [5] To what extent do you think issues described earlier can be mitigated by implementing blockchain solutions?
- [6] What could be prerequisites and preconditions for the implementation of Blockchain technology in your organization?
- [7] What can be prominent drivers for enabling blockchain in the supply chain?
- [8] What can be the major limitations that prevent the implementation of blockchain in the supply chain?

- [9] Any additional comments

Appendix 3: Interview Transcripts

9 Thesis Questionnaire - Integration of Blockchain with Supply chain

Using this questionnaire, I am researching about the extend to which decision makers see implementing blockchain as a way of optimizing supply chain, foreseeable future opportunities and limitations.

Email *

anubraham@gmail.com

Your Full Name *

Anup Chhokar

What is your current role in your company? To what extent are you involved with supply chain or IT? *

Sales Associate - TATA STEEL, partially involved as managing coordination between production plants and warehouses in different regions in India.

Are you aware of blockchain technology? Was it implemented in your organization? How was it implemented? If not, why ? *

Yes, I am aware. Yes implemented - Tata Steel + HSBC, executed a blockchain-enabled paperless trade transaction in 2021

Describe current and foreseeable issues in the supply chain in your organization? *

Current issues- untimely delivery of products, more administrative work, foreseeable issues- loss of revenues and less sales

To what extent do you think issues described earlier can be mitigated by implementing blockchain solutions? *

The use of blockchain technology in trade finance improves transaction security, reduced document negotiation, banking transaction cycles from weeks to a few days, speeds up the velocity of trade

What could be prerequisites and preconditions for the implementation of Blockchain technology in your organization? *

Staff engagement, trainings and workshops for new technology

What can be prominent drivers for enabling blockchain in the supply chain? *

Big data analytics, technology driven organization

What can be the major limitations that prevent the implementation of blockchain in the supply chain? *

No knowlegde of Blockchain technology

Any additional comments

Blockchain is the future of business transactions.

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10 Thesis Questionnaire - Integration of Blockchain with Supply chain

Using this questionnaire, I am researching about the extend to which decision makers see implementing blockchain as a way of optimizing supply chain, foreseeable future opportunities and limitations.

Email *

yadavgaurav989@gmail.com

Your Full Name *

Gaurav Yadav

What is your current role in your company? To what extent are you involved with supply chain or IT? *

Role: GTM consultant - VMware cloud.

My role revolves around offering best suited cloud native engineering capabilities to clients and help them attain optimal hybrid and multi cloud environment.

Are you aware of blockchain technology? Was it implemented in your organization? How was it implemented? If not, why? *

Yes, Wipro has numerous offerings of Block Chain. We help our customers with Blockchain platforms, advisory services and various industry based thematic solutions. We've helped lots of customer implement block chain. You can find case studies on www.wipro.com/blockchain

Describe current and foreseeable issues in the supply chain in your organization? *

Given the nature of our business, I don't see any supply chain issue in our IT services firm. We smoothly ensured business continuity of 200 thousand employees during pandemic.

To what extent do you think issues described earlier can be mitigated by implementing blockchain solutions? *

NA

What could be prerequisites and preconditions for the implementation of Blockchain technology in your organization? *

NA

What can be prominent drivers for enabling blockchain in the supply chain? *

I believe providing better customer experience, cost savings and security features will remain prominent drives.

In a competitive landscape, trying to create differentiated proposition can also be a key driver for adoption.

What can be the major limitations that prevent the implementation of blockchain in the supply chain? *

Lack of awareness, management vision, additional cost of implementation could be some reasons

Any additional comments

During my MBA internship, I worked in one of the largest medical device manufacturing company. They had 85% market share so being innovative or adopting latest technologies doesn't provide much benefits to such organization hence they tend to focus on BAU.

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11 Thesis Questionnaire - Integration of Blockchain with Supply chain

Using this questionnaire, I am researching about the extend to which decision makers see implementing blockchain as a way of optimizing supply chain, foreseeable future opportunities and limitations.

Email *

kaliaarjun123@gmail.com

Your Full Name *

Arjun Kalia

What is your current role in your company? To what extent are you involved with supply chain or IT? *

Sourcing & Supply Chain Manager-SAARC divison

Are you aware of blockchain technology? Was it implemented in your organization? How was it implemented? If not, why ? *

Yes, I'm aware of the technology. No, it hasn't been implemented in our organisation purely because the requirement of traceability is carried out through our forwarding agent. Also, it hasn't been deployed horizontally across the group

Describe current and foreseeable issues in the supply chain in your organization? *

With the delays in getting vessel schedules and in transit delays, material availability and customer commitments are taking a hit big time.

To what extent do you think issues described earlier can be mitigated by implementing blockchain solutions? *

It could help in real time tracking of incoming shipments and commit to the customer's accordingly.

What could be prerequisites and preconditions for the implementation of Blockchain technology in your organization? *

It has to be accepted and agreed by the Group's management and only then it can be deployed across our entities globally.

What can be prominent drivers for enabling blockchain in the supply chain? *

With the current competitive scenario it is imperative that we are on our toes with respect to material availability and this requirement will force organisations to adopt this technology which ensures they're aware of their shipment status at all times and since it reduces the chances of any breakage into the system it further gives organizations an incentive to adopt it.

What can be the major limitations that prevent the implementation of blockchain in the supply chain? *

Apprehensions if any by the organisation's management.

Any additional comments

None

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12 Thesis Questionnaire - Integration of Blockchain with Supply chain

Using this questionnaire, I am researching about the extend to which decision makers see implementing blockchain as a way of optimizing supply chain, foreseeable future opportunities and limitations.

Email *

shaus22@gmail.com

Your Full Name *

Jayaraj Arokiyasamy

What is your current role in your company? To what extent are you involved with supply chain or IT? *

Head of IT, Fully Involved in both Functions.

Are you aware of blockchain technology? Was it implemented in your organization? How was it implemented? If not, why ? *

I am aware of Blockchain, not implemented in our organization, It's not the right time. blockchain as a technology needs to evolve.

Describe current and foreseeable issues in the supply chain in your organization? *

Tracking Shipments end to end, Collaborating with all Suppliers, Partners, Traceability of Materials, real time connectivity and visibility of shippers and logistics partners.

To what extent do you think issues described earlier can be mitigated by implementing blockchain solutions? *

if blockchain is trusted by Suppliers, Logistics partners and if the security of sensitive information shared across parties ensured, then there is a possibility of these issues being addressed.

What could be prerequisites and preconditions for the implementation of Blockchain technology in your organization? *

1. it's very important to have clear guidelines and frameworks on Government, Legal and Compliance regulations to implement blockchain technology. 2. Blockchain technology Solutions/Systems to prove that it can be seamlessly integrated with Business Systems such as ERP or Accounting Systems.

What can be prominent drivers for enabling blockchain in the supply chain? *

Trust, Security, Regulations & Proven Solutions.

What can be the major limitations that prevent the implementation of blockchain in the supply chain? *

Scalability hasn't been proven yet, Transactions can't be overwritten and it's immutable.

Any additional comments

Researches suggest that the cost to operate blockchain solutions can be very high. Transparency and Confidentiality is a key issue. Also there are compatibility issues between blockchain traceability characteristics and real world traceability characteristics. Also there are not many success stories that would encourage and entice organizations to go for.

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13 Thesis Questionnaire - Integration of Blockchain with Supply chain

Using this questionnaire, I am researching about the extend to which decision makers see implementing blockchain as a way of optimizing supply chain, foreseeable future opportunities and limitations.

Email *

kapoor_palash@hotmail.com

Your Full Name *

Palash Kapoor

What is your current role in your company? To what extent are you involved with supply chain or IT? *

Sales Development Representative. My work revolves substantially around the IT space helping organizations with their CRM requirements customised to their business needs.

Are you aware of blockchain technology? Was it implemented in your organization? How was it implemented? If not, why ? *

Yes. Atleast a few, if not all products of my organization are built on hyperledger sawtooth protocol using blockchain at the core.

Describe current and foreseeable issues in the supply chain in your organization? *

N/A

To what extent do you think issues described earlier can be mitigated by implementing blockchain solutions? *

N/A

What could be prerequisites and preconditions for the implementation of Blockchain technology in your organization? *

The core idea of using blockchain at my organization was to establish trust for secure data access and transfer which is of utmost importance in the IT space dealing with multitudes of highly sensitive data.

What can be prominent drivers for enabling blockchain in the supply chain? *

Prominent drivers could be business impact on the lines of a leaner supply chain leading to cost-efficiency and enhanced control over the entire supply chain lifecycle. Security could be another important aspect in all businesses including supply chain.

What can be the major limitations that prevent the implementation of blockchain in the supply chain? *

High cost and time involved in the implementation of blockchain would be one major drawback. Lack of skilled resource in a domain as new as Blockchain is also a challenge right now.

Any additional comments

Along with a thorough cost-benefit analysis, Blockchain's fitment into the long term vision of a particular organization must be at the center of any and all decisions. Implementing Blockchain is a long term commitment at the very least and must be pondered upon by the decision makers with future goals in mind.

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14 Thesis Questionnaire - Integration of Blockchain with Supply chain

Using this questionnaire, I am researching about the extend to which decision makers see implementing blockchain as a way of optimizing supply chain, foreseeable future opportunities and limitations.

Email *

meetparikh.ind@gmail.com

Your Full Name *

Meet Prabodhkumar Parikh

What is your current role in your company? To what extent are you involved with supply chain or IT? *

I am a Project Manager in IT product based company. I have an experience involved in Supply Chain process

Are you aware of blockchain technology? Was it implemented in your organization? How was it implemented? If not, why ? *

Yes, I am aware about Blockchain Technology yes it is implemented in our Organisation.it was used in one of our product's service. It's decentralised system that allows information to be distributed securely.

Describe current and foreseeable issues in the supply chain in your organization? *

Currently, where I am working not being part of it this process but yes based on my previous experience I would like to say. From vendor source to product management and delivery to client comes in supply chain management

To what extent do you think issues described earlier can be mitigated by implementing blockchain solutions? *

It is about, if someone were to send you an email today with an attachment, you wouldn't be opening the exact attachment that they sent you, instead, you will be reading a digital recreation of that attachment. with Blockchain you can exchange an actual piece of data without needing a mutually trusted broker in the middle of your transaction.

What could be prerequisites and preconditions for the implementation of Blockchain technology in your organization? *

To understand how much importance of decentralised system with secure transaction. Then Tech Engineers play the role for development who are highly qualified.

What can be prominent drivers for enabling blockchain in the supply chain? *

Product Data.

What can be the major limitations that prevent the implementation of blockchain in the supply chain? *

Compare to traditional database, Blockchain significantly slower in retrieving and committing the record

Any additional comments

This is the Future

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15 Thesis Questionnaire - Integration of Blockchain with Supply chain

Using this questionnaire, I am researching about the extend to which decision makers see implementing blockchain as a way of optimizing supply chain, foreseeable future opportunities and limitations.

Email *

jyothitauro@gmail.com

Your Full Name *

Jyoti Tauro

What is your current role in your company? To what extent are you involved with supply chain or IT? *

Senior Financial Analyst. Have some knowledge on blockchain with supply chain

Are you aware of blockchain technology? Was it implemented in your organization? How was it implemented? If not, why ? *

Yes. The technology is studied and in nascent stage in the process of implementation.

Describe current and foreseeable issues in the supply chain in your organization? *

The current issue remains with legacy structures and patterns in the way business was done. Bringing that to a closure and adopting new technologies is one issue. Second is the new business process, understanding the entire supply chain needs in the new digital world is complex to fulfill the end user needs. Another issue is that data on the ledger cannot be erased or reversed, so carefully it must be implemented. Leaders have trust issues.

To what extent do you think issues described earlier can be mitigated by implementing blockchain solutions? *

Being mindful and have a complete understanding of it is important from the beginning.

What could be prerequisites and preconditions for the implementation of Blockchain technology in your organization? *

Cost is the first thing, next is trust in the organization implementing it with transparency being the core.

What can be prominent drivers for enabling blockchain in the supply chain? *

scalability is one factor, integration and transparency to all stakeholders

What can be the major limitations that prevent the implementation of blockchain in the supply chain? *

trust among the stakeholders and analytics

Any additional comments

None



16 Thesis Questionnaire - Integration of Blockchain with Supply chain

Using this questionnaire, I am researching about the extend to which decision makers see implementing blockchain as a way of optimizing supply chain, foreseeable future opportunities and limitations.

Email *

vikrant.mhatre2104@gmail.com

Your Full Name *

Vikrant Mhatre

What is your current role in your company? To what extent are you involved with supply chain or IT? *

Business Analyst

Are you aware of blockchain technology? Was it implemented in your organization? How was it implemented? If not, why ? *

Yes I'm aware. No, it's in a nascent stage

Describe current and foreseeable issues in the supply chain in your organization? *

Turn around time is too high.

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described earlier can be mitigated by implementing

conditions for the implementation of Blockchain

needed to understand the implications and benefits for it to be

implementing blockchain in the supply chain? *

prevent the implementation of blockchain in the supply

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17 Thesis Questionnaire - Integration of Blockchain with Supply chain

Using this questionnaire, I am researching about the extend to which decision makers see implementing blockchain as a way of optimizing supply chain, foreseeable future opportunities and limitations.

Email *

uarora@ncsu.edu

Your Full Name *

Ujjwal Arora

What is your current role in your company? To what extent are you involved with supply chain or IT? *

I am a Hardware Architect , I am not involved in either supply chain or IT

Are you aware of blockchain technology? Was it implemented in your organization? How was it implemented? If not, why ? *

There are discussions ongoing on how to incorporate Blockchain in various IPs in our organisation but nothing concrete so far

oog e

Describe current and foreseeable issues in the supply chain in your organization? *

Inertia to adoption, lack of knowhow

described earlier can be mitigated by implementing

...ive, so people are more resistant to adopting new
...m even considering adoption of Blockchain

...ditions for the implementation of Blockchain

...still in early stages of adoption throughout the Tech world so
...routine

...ing blockchain in the supply chain? *

...revent the implementation of blockchain in the supply

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18 Thesis Questionnaire - Integration of Blockchain with Supply chain

Using this questionnaire, I am researching about the extend to which decision makers see implementing blockchain as a way of optimizing supply chain, foreseeable future opportunities and limitations.

Email *

naren_mahajan@yahoo.com

Your Full Name *

Naren Mahajan

What is your current role in your company? To what extent are you involved with supply chain or IT? *

SAP Consultant. My job profile is related to IT.

oog e

Are you aware of blockchain technology? Was it implemented in your organization? How was it implemented? If not, why ? *

Yes. It is implemented in the organization.

Describe current and foreseeable issues in the supply chain in your organization? *

Managing demand and supply.

described earlier can be mitigated by implementing

conditions for the implementation of Blockchain

Implementing blockchain in the supply chain? *

Implement the blockchain.

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prevent the implementation of blockchain in the supply

The supply chain is not stable. The data required to

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19 Thesis Questionnaire - Integration of Blockchain with Supply chain

Using this questionnaire, I am researching about the extend to which decision makers see implementing blockchain as a way of optimizing supply chain, foreseeable future opportunities and limitations.

Email *

mudgal.rishabh@gmail.com

Your Full Name *

Rishabh Mudgal

Google

What is your current role in your company? To what extent are you involved with supply chain or IT? *

Product Lead - Middle and Last Mile (80-90% involved)

Are you aware of blockchain technology? Was it implemented in your organization? How was it implemented? If not, why ? *

I am aware about blockchain on a basic level. Walmart hasn't implemented blockchain as the technology knowledge (engineering knowledge) in organization is not present. I believe a few POC are in flight.

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Describe current and foreseeable issues in the supply chain in your organization? *

1. Proper sourcing (Source - Avoiding fakes)
2. Understand needs of customers beforehand to ensure correct SKUs are stocked
3. Delivery lead time
4. Quality of product (GMO, Non-GMO, Organic etc.) (fraud detection maybe)
5. Money transaction record keeping.

To what extent do you think issues described earlier can be mitigated by implementing blockchain solutions? *

Most of it if technology knowledge is easy to acquire. I am not sure how difficult it would be to manager a technology like blockchain on long term.

What could be prerequisites and preconditions for the implementation of Blockchain technology in your organization? *

1. Engineering knowledge.
2. Sr leadership buy-in and basic knowledge/understanding
3. Long term benefit out weigh maintenance and development cost.
4. Technology infrastructure (if any)
5. Data pipeline
6. Partner technology if needed (vendors etc.)

What can be prominent drivers for enabling blockchain in the supply chain? *

N/A

What can be the major limitations that prevent the implementation of blockchain in the supply chain? *

Technology knowledge, infrastructure and Sr leadership's lack of knowledge on the benefit, Cost of implementation and maintenance.

[Empty form box]

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20 Thesis Questionnaire - Integration of Blockchain with Supply chain

Using this questionnaire, I am researching about the extend to which decision makers see implementing blockchain as a way of optimizing supply chain, foreseeable future opportunities and limitations.

Email *

shrey.gera@gmail.com

Your Full Name *

Shrey Gera

What is your current role in your company? To what extent are you involved with supply chain or IT? *

Packaging engineer. Handling inventory needed for the assembly line

Are you aware of blockchain technology? Was it implemented in your organization? How was it implemented? If not, why ? *

Yes, aware. I don't think so.

Describe current and foreseeable issues in the supply chain in your organization? *

Ordering parts even if the production is down.

described earlier can be mitigated by implementing

Conditions for the implementation of Blockchain

Implementing blockchain in the supply chain? *

What prevents the implementation of blockchain in the supply

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21 Thesis Questionnaire - Integration of Blockchain with Supply chain

Using this questionnaire, I am researching about the extend to which decision makers see implementing blockchain as a way of optimizing supply chain, foreseeable future opportunities and limitations.

Email *

krutarth493@gmail.com

Your Full Name *

Krutarth Dave

What is your current role in your company? To what extent are you involved with supply chain or IT? *

IT Analyst.

Are you aware of blockchain technology? Was it implemented in your organization? How was it implemented? If not, why ? *

Yes. Thyssenkrupp uses blockchain for financial transactions or bitcoins. It also uses it for a secure and multi site exchange of production data.

Describe current and foreseeable issues in the supply chain in your organization? *

The material and parts production seems to be less efficient.

described earlier can be mitigated by implementing

ty. This will mitigate the issue to a large extent. The company
ent blockchain for 3D printing parts.

Conditions for the implementation of Blockchain

solution and the target area. High level signoffs.

Implementing blockchain in the supply chain? *

What prevents the implementation of blockchain in the supply

chain? For example, it does have an upfront cost attached to it. There is a lack of data infrastructure.

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22 Thesis Questionnaire - Integration of Blockchain with Supply chain

Using this questionnaire, I am researching about the extent to which decision makers see implementing blockchain as a way of optimizing supply chain, foreseeable future opportunities and limitations.

Email *

incore.labs.np@gmail.com

Your Full Name *

Neelabh Pandey

What is your current role in your company? To what extent are you involved with supply chain or IT? *

Software Engineer

Are you aware of blockchain technology? Was it implemented in your organization? How was it implemented? If not, why ? *

We don't have blockchain since our product has not thought of the possibility or looked into it. Might not be a usecase for us.

Describe current and foreseeable issues in the supply chain in your organization? *

We don't deal with supply chain.

described earlier can be mitigated by implementing

conditions for the implementation of Blockchain

...ing blockchain in the supply chain? *

...prevent the implementation of blockchain in the supply

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23 Thesis Questionnaire - Integration of Blockchain with Supply chain

Using this questionnaire, I am researching about the extend to which decision makers see implementing blockchain as a way of optimizing supply chain, foreseeable future opportunities and limitations.

Email *

rutvijvaishnav@gmail.com

Your Full Name *

Rutvij Vaishnav

What is your current role in your company? To what extent are you involved with supply chain or IT? *

Owner. Completely involved from sourcing to supplying.

Are you aware of blockchain technology? Was it implemented in your organization? How was it implemented? If not, why? *

Aware of it: Yes

Implemented: No

Why?: In the Indian Manufacturing sector lots of unorganized supply chain partners form the major part of the supply chain. Implementing block chain through them is a very difficult task in the presence scenario. Because of lack of awareness, implementation technologies in the rural regions, education level in the blue collar workers of these unorganized supply chain partners and lack of financial resources it becomes nearly impossible task at this moment to implement at our organization.

Describe current and foreseeable issues in the supply chain in your organization? *

1) Transportation:

Increasing freights

Shortage of containers

Increasing fuel prices

2) Uncertainty in the Markets:

Fluctuating demands with fluctuating commodity prices

Stock keeping and maintaining:

3) International Conflicts:

e.g. Indo-China conflicts causing shortage of electronic components delaying our machinery schedules

To what extent do you think issues described earlier can be mitigated by implementing blockchain solutions? *

For our organization, a little can be solved by that in the immediate times

What could be prerequisites and preconditions for the implementation of Blockchain technology in your organization? *

Technology availability

Organized supply chain partners

Education in employees managing the blockchain

What can be prominent drivers for enabling blockchain in the supply chain? *

Can shorten the cash cycle

Ease in stock keeping

Tracking can become easy

prevent the implementation of blockchain in the supply

.....

.....

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24 Thesis Questionnaire - Integration of Blockchain with Supply chain

Using this questionnaire, I am researching about the extend to which decision makers see implementing blockchain as a way of optimizing supply chain, foreseeable future opportunities and limitations.

Email *

nishant998877@gmail.com

Your Full Name *

Nishant Patel

What is your current role in your company? To what extent are you involved with supply chain or IT? *

Sr. Machine Learning scientist. Our business revolves around supply chain tracking using IOT sensors.

Are you aware of blockchain technology? Was it implemented in your organization? How was it implemented? If not, why ? *

Yes I'm aware of what blockchain is. We tried to implement it in our devices to bring more confidence to the data our IOT sensors collects (e.g. temperature reading of a shipment throughout the journey).

Describe current and foreseeable issues in the supply chain in your organization? *

For us the main problem was power consumption of the blockchain calculations. Our devices collect data every few minutes and as they are edge devices; any added computation shrinks down the timespan the device can be used for between recharge cycle. So, introducing blockchain literally halved the time it can stay in action; which is big deal breaker for long running multimodal shipments (e.g. going from china to USA; it takes 25+ days and if our devices can't last that long then it's deal breaker)

To what extent do you think issues described earlier can be mitigated by implementing blockchain solutions? *

Blockchain was experimented on in our company to add the extra confidence that the temperature/humidity/shock readings were authentic and wasn't changed/tampered with; but doing so reduced the timespan of our devices. So even though the confidence was boosted; practically it wasn't just feasible to deploy it for live customer devices.

What could be prerequisites and preconditions for the implementation of Blockchain technology in your organization? *

Technological know-how is primary and Domain use-case deep knowledge is also essential.

What can be prominent drivers for enabling blockchain in the supply chain? *

To be honest it's more of a buzz generating tool than being actually useful. In supply chain the only practical usecase i can see is to maintain service agreements and contracts between logistics service provider and consumer so that none of the party can shy/sway away from their own agreements. All the other usecases are shallow or straight up impractical; it's like taking a train to go 2 miles just to show-off.

prevent the implementation of blockchain in the supply

ed technology and only few people truly knows it and can

ility of the block chain itself. People with shallow knowledge products and solution; which is simply not the case and born out

an actually being useful. It do have the niche use-cases like that's about it. There's high correlation when block chain is in their pockets! So, no wonder literally every single startup tried to launch their product offerings.

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25 Thesis Questionnaire - Integration of Blockchain with Supply chain

Using this questionnaire, I am researching about the extend to which decision makers see implementing blockchain as a way of optimizing supply chain, foreseeable future opportunities and limitations.

Email *

vyas.het19@gmail.com

Your Full Name *

Het Alkesh Vyas

What is your current role in your company? To what extent are you involved with supply chain or IT? *

Project Manager and Marketing Executive

Are you aware of blockchain technology? Was it implemented in your organization? How was it implemented? If not, why? *

Yes I'm aware. It was not implemented in our organization because it is costly for a company which operates in local market.

Describe current and foreseeable issues in the supply chain in your organization? *

Transparency of data is current issue in our organization as each Big warehouses have different reporting styles based on the locations. It is difficult to maintain and analyze the data. Which can be eradicated with the use of Blockchain technology as it will have symmetrical reporting systems with Transparency.

To what extent do you think issues described earlier can be mitigated by implementing blockchain solutions? *

90% of Issues can be mitigated with the use of Blockchain solutions.

What could be prerequisites and preconditions for the implementation of Blockchain technology in your organization? *

1. Decentralization of systems
2. Training of employees
3. Hands on experience with platform
4. Understanding of Blockchain security

What can be prominent drivers for enabling blockchain in the supply chain? *

1. Accurate tracking of supplies
2. Decentralization record for transactions
3. Better data understanding

What can be the major limitations that prevent the implementation of blockchain in the supply chain? *

1. Cost is major limitations for implementation of blockchain in our organization.

For Supplychain - Limitation can be based on the size of company for e.g. small companies see no use of blockchain as the operations are small and limited.

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26 Thesis Questionnaire - Integration of Blockchain with Supply chain

Using this questionnaire, I am researching about the extend to which decision makers see implementing blockchain as a way of optimizing supply chain, foreseeable future opportunities and limitations.

Email *

darshit.shah.iitkgp@gmail.com

Your Full Name *

Darshit Shah

What is your current role in your company? To what extent are you involved with supply chain or IT? *

I work as a supply chain strategy consultant to advise clients to improve their supply chains. I am completely involved with the supply chain and too some extent technology fields.

Are you aware of blockchain technology? Was it implemented in your organization? How was it implemented? If not, why ? *

Yes, I am aware of the technology and its use cases and instances. But, i have not witnessed it getting implemented nor we have proposed any client thus far for the same.

Describe current and foreseeable issues in the supply chain in your organization? *

Typical issues that we observe in the firms at the moment:

- 1. Lack of resilience and flexibility in the supply chain
 - 2. Difficult to contain supply chain costs due to current market conditions
 - 3. Increased complexities in supply chain processes
-

To what extent do you think issues described earlier can be mitigated by implementing blockchain solutions? *

Technology is a key factor that brings resilience in the supply chain. With blockchain comes the traceability, and it should reduce the risk to a great extent.

What could be prerequisites and preconditions for the implementation of Blockchain technology in your organization? *

N/A

What can be prominent drivers for enabling blockchain in the supply chain? *

Data maturity and culture of sustained innovation

What can be the major limitations that prevent the implementation of blockchain in the supply chain? *

Less awareness of the use cases to the leaderships

Any additional comments

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27 Thesis Questionnaire - Integration of Blockchain with Supply chain

Using this questionnaire, I am researching about the extend to which decision makers see implementing blockchain as a way of optimizing supply chain, foreseeable future opportunities and limitations.

Email *

sohaib.sulaiman@gmail.com

Your Full Name *

Sohaib Sulaiman

What is your current role in your company? To what extent are you involved with supply chain or IT? *

Area Sales Manager. I have regular coordination with supply chain team to ensure local availability of products

Are you aware of blockchain technology? Was it implemented in your organization? How was it implemented? If not, why ? *

Yes I am aware. No it has not been implemented since the management is not very keen to introduce it

Describe current and foreseeable issues in the supply chain in your organization? *

Global raw material shortage can severely impact local availability if forecasting is not done appropriately

described earlier can be mitigated by implementing

Conditions for the implementation of Blockchain

Implementing blockchain in the supply chain? *

What is the advantage of using such technology

What prevents the implementation of blockchain in the supply

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28 Thesis Questionnaire - Integration of Blockchain with Supply chain

Using this questionnaire, I am researching about the extent to which decision makers see implementing blockchain as a way of optimizing supply chain, foreseeable future opportunities and limitations.

Email *

gouthamravi1995@gmail.com

Your Full Name *

Goutham Ravichandiran

What is your current role in your company? To what extent are you involved with supply chain or IT? *

UX designer

Are you aware of blockchain technology? Was it implemented in your organization? How was it implemented? If not, why ? *

Heard about it but I was never involved in its implementation

Describe current and foreseeable issues in the supply chain in your organization? *

Supply chain with respect to the hardware we are facing due to availability of chit sets etc. With respect to software we aren't facing anyway at this point in time.

To what extent do you think issues described earlier can be mitigated by implementing blockchain solutions? *

I am not fully aware of this

What could be prerequisites and preconditions for the implementation of Blockchain technology in your organization? *

I am not familiar with the implementation perspective. I have heard about it but don't have deeper understanding on blockchain.

What can be prominent drivers for enabling blockchain in the supply chain? *

Problems in existing supply chain traceability systems, which are either difficult or impossible to solve with current technologies, include establishing reliable provenance, and preventing fraud and counterfeiting. Existing traceability systems adopt either a centralized or distributed architecture. Blockchain is a promising technology for addressing these issues which brings three major benefits: (i) secure traceability and control, (ii) data immutability and (iii) trust creation, in relatively low cost IT solutions.

What can be the major limitations that prevent the implementation of blockchain in the supply chain? *

Non technical challenges - many warehouses still operate with paper at the integral points, although RFID chips and scanners are now conveniently available. Technical challenges - interoperability and flexibility of the integrating existing systems. Scability is an another limitation.

Any additional comments

If you could provide a better view of the blockchain it would actually help people answer these questions in a much more differently.

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29 Thesis Questionnaire - Integration of Blockchain with Supply chain

Using this questionnaire, I am researching about the extend to which decision makers see implementing blockchain as a way of optimizing supply chain, foreseeable future opportunities and limitations.

Email *

abhipraay2705@gmail.com

Your Full Name *

Abhipraay Bajpai

What is your current role in your company? To what extent are you involved with supply chain or IT? *

I work as a consultant in the Supply Chain practice for a Management Consulting firm.

Are you aware of blockchain technology? Was it implemented in your organization? How was it implemented? If not, why ? *

Over the past 5 years, the development of blockchain based solutions has intensified across the IT consulting industry. Presently the solutions are developed for a variety of industries but the adoption has been slow due to trust and data privacy issues. According to a 2018 survey by our firm,

- only 3% of the organisations deployed blockchain at scale
- 10% are at an advanced stage of experimentation, with pilots in at least one site
- 87% are at early experimental or proof of concept stage

Describe current and foreseeable issues in the supply chain in your organization? *

NA (Our firm is a provider of blockchain solutions for other organizations)

To what extent do you think issues described earlier can be mitigated by implementing blockchain solutions? *

- Lack of traceability : Audit trail for all transactions
- Risks involved with multiple stakeholders : Immutable & secure against undesired changes
- Lack of responsiveness : Near real time
- Huge amount of manual processing : Faster digital record generation
- Regulatory compliance : Tamper proof data which can be easily verified
- Reconciliation burden : Single shared source of truth

What could be prerequisites and preconditions for the implementation of Blockchain technology in your organization? *

Blockchain has great potential in,

- Manufacturing : Supplier contract management, digital thread, tracking production, asset maintenance and recalled parts
- Consumer products : Tracking provenance and critical parameters, monitoring asset conditions, providing warranties
- Retail : marketplaces, prevention of counterfeits, inventory & pilferage tracking, returned goods tracking, loyalty program management

Another area of implementation involves investing in sustainable supply chains through carbon emission tracking

Requirements include,

- Consistent and robust MIS in place
- Successful proof of concept
- Regulatory compliance
- High initial investment

...ing blockchain in the supply chain? *

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30 Thesis Questionnaire - Integration of Blockchain with Supply chain

Using this questionnaire, I am researching about the extend to which decision makers see implementing blockchain as a way of optimizing supply chain, foreseeable future opportunities and limitations.

Email *

juhitripathi18@gmail.com

Your Full Name *

Juhi Tripathi

What is your current role in your company? To what extent are you involved with supply chain or IT? *

Current role : Senior Software Engineer, that falls under IT organizational structure. I have no involvement in supply chain.

Are you aware of blockchain technology? Was it implemented in your organization? How was it implemented? If not, why ? *

Yes, my organization is connecting crypto and blockchain networks to our global payment network. Universal Payment Channel (UPC), developed at my organization acts as a hub, interconnecting multiple blockchain networks, allowing a secure transfer of digital currencies.

s in the supply chain in your organization? *

described earlier can be mitigated by implementing

Conditions for the implementation of Blockchain

with the technology

Implementing blockchain in the supply chain? *

What prevents the implementation of blockchain in the supply

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31 Thesis Questionnaire - Integration of Blockchain with Supply chain

Using this questionnaire, I am researching about the extent to which decision makers see implementing blockchain as a way of optimizing supply chain, foreseeable future opportunities and limitations.

Email *

manikgauravvig@gmail.com

Your Full Name *

Manik Vig

What is your current role in your company? To what extent are you involved with supply chain or IT? *

Capacity Planning in Supply Chain

Are you aware of blockchain technology? Was it implemented in your organization? How was it implemented? If not, why ? *

Not implemented yet, technology is too nascent

Describe current and foreseeable issues in the supply chain in your organization? *

Chip shortage, excess and obsolete inventory, slow capacity ramp up

described earlier can be mitigated by implementing

inventory, preventing obsolescence costs

Conditions for the implementation of Blockchain

Implementing blockchain in the supply chain? *

What prevents the implementation of blockchain in the supply

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32 Thesis Questionnaire - Integration of Blockchain with Supply chain

Using this questionnaire, I am researching about the extent to which decision makers see implementing blockchain as a way of optimizing supply chain, foreseeable future opportunities and limitations.

Email *

pratik.patil.all@gmail.com

Your Full Name *

Pratik Patil

What is your current role in your company? To what extent are you involved with supply chain or IT? *

I am currently an MBA student at NITIE Mumbai, considered as one of the top institutes in India for Operations/Supply Chain Management domain. I'll be joining Amazon as a Level 5 Program Manager from the next financial year. I have a 4-year experience working on SAP infra, 2-month seller classification framework development experience in Amazon and 3-month operations consulting and capacity planning experience for Bajaj Electricals Limited.

Are you aware of blockchain technology? Was it implemented in your organization? How was it implemented? If not, why? *

In my experience, I have not seen Blockchain being used on a commercial scale in Indian supply chains. However, there is a rapid increase in awareness among the middle management. I have seen my seniors, fellow batchmates creating ready-to-implement models based on Blockchain during their internships. Their SCM projects were spread across a wide range of domains like FMCG, Pharma, Textile, Infrastructure, Ecommerce. Blockchain being a relatively newer technology, it is easier for new generation managers to upskill themselves and implement it in their organizations.

Describe current and foreseeable issues in the supply chain in your organization? *

In my opinion, the majority of SCM issues arise because of inaccurate forecasting models. A slight miscalculation creates ripples up the supply chain. We have seen this issue more prevalent after the COVID disruptions. I have seen my friends investing a lot of time in adjusting their forecasting models factoring in seasonality, demand and the desired service level of the company.

To what extent do you think issues described earlier can be mitigated by implementing blockchain solutions? *

There are many advanced EDI technologies that are already in use for ease of transactions. Using IoT (as simple as RFID tags) to ERP, the paperless transaction and tracking is quite sophisticated as it is today. I think that we can use Blockchains to increase the visibility of transactions throughout the supply chain and remove the data from silos. This will help decision making right from vendors to customers and adjust as per their own bottlenecks.

What could be prerequisites and preconditions for the implementation of Blockchain technology in your organization? *

I think we need large server storage spaces and computing power at each node of the supply chain. With increasing access to these equipment, blockchain becomes more feasible. As I mentioned earlier, we need upskilling and introduction of young managers to convert the traditional systems to newer ones.

What can be prominent drivers for enabling blockchain in the supply chain? *

Well, I can think of a lot of SCM drivers. Imagining a blockchain model, I can list a few major ones on the top of my head:

cycle, lead times

SKU data

Service Level

Fill rate/demand

purchase prices at each point

Outstanding payments

Order sizes

What prevent the implementation of blockchain in the supply

power, upskilling at each node. Besides, a blockchain will require a lot of algorithm changes. Also, it will solve only the problem. Still will be needed for user interaction.

My observations. I have personally not worked in SCM or Blockchain. I have knowledge as an operation student.

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33 Thesis Questionnaire - Integration of Blockchain with Supply chain

Using this questionnaire, I am researching about the extend to which decision makers see implementing blockchain as a way of optimizing supply chain, foreseeable future opportunities and limitations.

Email *

jayrajtrivedi77@gmail.com

Your Full Name *

Jayraj Trivedi

What is your current role in your company? To what extent are you involved with supply chain or IT? *

Working as a IT consultant. Does not involve supply chain but involves IT

Are you aware of blockchain technology? Was it implemented in your organization? How was it implemented? If not, why ? *

Aware about it but have no exposure to it.

It was not implemented in my organization as it was not applicable for the domains which I was working on.

Describe current and foreseeable issues in the supply chain in your organization? *

No transparency, inefficient tracking, not so secure, needs a lot of manpower whereas these days the organization is looking for cost cutting given the situation of a vulnerable market.

described earlier can be mitigated by implementing

ve could be addressed using the block chain methodology.

reconditions for the implementation of Blockchain

nter to help the stakeholders adapt to the new methodology

enabling blockchain in the supply chain? *

Artificial intelligence, increasing Globalization, Highly skilled

hat prevent the implementation of blockchain in the supply

r time to market

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34 Thesis Questionnaire - Integration of Blockchain with Supply chain

Using this questionnaire, I am researching about the extend to which decision makers see implementing blockchain as a way of optimizing supply chain, foreseeable future opportunities and limitations.

Email *

erik@bsca.global

Your Full Name *

Erik Valiquette

What is your current role in your company? To what extent are you involved with supply chain or IT? *

CEO of the Blockchain Supply Chain Association

Are you aware of blockchain technology? Was it implemented in your organization? How was it implemented? If not, why ? *

It has been implemented in many of our member's organizations

Describe current and foreseeable issues in the supply chain in your organization? *

Supply chains are critical to our every day lives and the current pandemic has shown us how fragile our supply chains are. Too many "issues" to describe here. But using antiquated methodologies and paper based processes are at the core of several of these disruptive issues.

described earlier can be mitigated by implementing

mination of paper based processes, including the use of trusted
reduce waste. Wasted energy, wasted time, wasted resources.

reconditions for the implementation of Blockchain

ion's business processes and the business processes of your entire
 ata silos and re-thinking how we exchange information in our supply

enabling blockchain in the supply chain? *

hat prevent the implementation of blockchain in the supply

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35 Thesis Questionnaire - Integration of Blockchain with Supply chain

Using this questionnaire, I am researching about the extend to which decision makers see implementing blockchain as a way of optimizing supply chain, foreseeable future opportunities and limitations.

Email *

kevin.bao@yutopy.com

Your Full Name *

Kevin Bao

What is your current role in your company? To what extent are you involved with supply chain or IT? *

CEO, 100% in both

Are you aware of blockchain technology? Was it implemented in your organization? How was it implemented? If not, why? *

Yes, used as base layer for data. Implemented from the ground up

Describe current and foreseeable issues in the supply chain in your organization? *

Traceability, visibility, data redundancy, security

described earlier can be mitigated by implementing

reconditions for the implementation of Blockchain

chain company

enabling blockchain in the supply chain? *

, and use a lot of resources to ETL data

What prevent the implementation of blockchain in the supply

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36 Thesis Questionnaire - Integration of Blockchain with Supply chain

Using this questionnaire, I am researching about the extend to which decision makers see implementing blockchain as a way of optimizing supply chain, foreseeable future opportunities and limitations.

Email *

sujar.jacob@koutfood.com

Your Full Name *

Sujar Jacob

What is your current role in your company? To what extent are you involved with supply chain or IT? *

Distribution Center Management & Projects

Are you aware of blockchain technology? Was it implemented in your organization? How was it implemented? If not, why ? *

Yes i am aware of the BlockChain Technology. We are now working to enhance our SAP to have WMS first.

Describe current and foreseeable issues in the supply chain in your organization? *

1. Supply Chain Interruption (Container delays | Production Issues | Shipping congestion & delays) 2. Increased Price Hike 3. Increased Stock Holding days & Blocking Capital

described earlier can be mitigated by implementing

reconditions for the implementation of Blockchain

ch 2. Investment

enabling blockchain in the supply chain? *

What prevent the implementation of blockchain in the supply

Willingness to Change

COPEX Model to encourage companies to initiate and transform

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37 Thesis Questionnaire - Integration of Blockchain with Supply chain

Using this questionnaire, I am researching about the extend to which decision makers see implementing blockchain as a way of optimizing supply chain, foreseeable future opportunities and limitations.

Email *

anishagoel25993@gmail.com

Your Full Name *

Anisha Goel

What is your current role in your company? To what extent are you involved with supply chain or IT? *

I'm IT Project Manager in Cisco. My work mainly involves IT and about 20% supply chain management.

Are you aware of blockchain technology? Was it implemented in your organization? How was it implemented? If not, why? *

Yes I am aware. Yes my organization was one of the first ones to implement blockchain. Cisco has made open source its Enterprise Blockchain technology so that it will be available to all customers, partners, and developers.

Describe current and foreseeable issues in the supply chain in your organization? *

Covid restrictions could deeply halt supply chains which are dependent on different countries for different parts.

To what extent do you think issues described earlier can be mitigated by implementing blockchain solutions? *

Blockchain can help in better tracking all the parts and giving a systematic and secure flow to the chaos after covid.

What could be prerequisites and preconditions for the implementation of Blockchain technology in your organization? *

Good connectivity with strong bandwidth, storage capacity, technical skills for resources, Networking hardware, ERP system

What can be prominent drivers for enabling blockchain in the supply chain? *

Various sensing, communication, storage and processing technologies such as the Internet of Things (IoT), 5G, cloud computing, Edge/Fog computing and data science have enhanced the digital capabilities in the organizational layers of the supply chain.

What can be the major limitations that prevent the implementation of blockchain in the supply chain? *

Scalability, limited connectivity or technical issues, complexity of application, insufficient funds, lack of technical skills, still in development stage

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38 Thesis Questionnaire - Integration of Blockchain with Supply chain

Using this questionnaire, I am researching about the extend to which decision makers see implementing blockchain as a way of optimizing supply chain, foreseeable future opportunities and limitations.

Email *

pranshukumar92@gmail.com

Your Full Name *

Pranshu Kumar

What is your current role in your company? To what extent are you involved with supply chain or IT? *

Product Manger

Not involved in supply chain or IT.

Are you aware of blockchain technology? Was it implemented in your organization? How was it implemented? If not, why ? *

Yes.

No, my organization does not rely on blockchains today. It is still being researched internally and might be considered as a technology we rely on in the future.

Describe current and foreseeable issues in the supply chain in your organization? *

N/A

To what extent do you think issues described earlier can be mitigated by implementing blockchain solutions? *

N/A

What could be prerequisites and preconditions for the implementation of Blockchain technology in your organization? *

Maturing of the blockchain technology will definitely be a precondition before my company decides on adopting it.

What can be prominent drivers for enabling blockchain in the supply chain? *

I think just the wider adoption of the tech. in the industry over time will drive this

What can be the major limitations that prevent the implementation of blockchain in the supply chain? *

1. Finding Developers who are experts
2. Common knowledge and easy learning around blockchain tech.

Any additional comments

N/A

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39 Thesis Questionnaire - Integration of Blockchain with Supply chain

Using this questionnaire, I am researching about the extend to which decision makers see implementing blockchain as a way of optimizing supply chain, foreseeable future opportunities and limitations.

Email *

tmankit01@gmail.com

Your Full Name *

Ankit

What is your current role in your company? To what extent are you involved with supply chain or IT? *

Data Scientist

Are you aware of blockchain technology? Was it implemented in your organization? How was it implemented? If not, why ? *

Yes, I am aware of it. It is not implemented in my org as we are a FINANCE company

Describe current and foreseeable issues in the supply chain in your organization? *

NA

described earlier can be mitigated by implementing

reconditions for the implementation of Blockchain

enabling blockchain in the supply chain? *

what prevent the implementation of blockchain in the supply

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40 Thesis Questionnaire - Integration of Blockchain with Supply chain

Using this questionnaire, I am researching about the extend to which decision makers see implementing blockchain as a way of optimizing supply chain, foreseeable future opportunities and limitations.

Email *

kshivank@gmail.com

Your Full Name *

Shivank Goel

What is your current role in your company? To what extent are you involved with supply chain or IT? *

Product Manager, Not involved in Supply chain but responsible for digital workflow management

Are you aware of blockchain technology? Was it implemented in your organization? How was it implemented? If not, why ? *

Not implemented as there is no clear business use case identified/explored as of today

Describe current and foreseeable issues in the supply chain in your organization? *

a) Providing more accurate and transparent end to end tracking of products b) Reducing transaction costs with supply chain vendors c) Process automation throughout the supply chain

To what extent do you think issues described earlier can be mitigated by implementing blockchain solutions? *

All the issues can be addressed using a blockchain to a large extent

What could be prerequisites and preconditions for the implementation of Blockchain technology in your organization? *

- a) Building awareness and understanding of blockchain as a technology amongst the management teams
- b) Identifying the business case and quantifiable benefits of implementing the the technology c) Employee competency to build and maintain the blockchain systems

What can be prominent drivers for enabling blockchain in the supply chain? *

- a) Potential quantifiable financial benefits b) Brand/Reputation benefits from implementation of blockchain

What can be the major limitations that prevent the implementation of blockchain in the supply chain? *

- a) Management buy in and understanding of the potential of the technology b) Time & money required to build competency in staff throughout the supply chain to manage the IT systems that they will interface with

Any additional comments

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Appendix 4: Results of code references of NVivo

Name	Code	Reference
Kevin Bao	8	12
Jyoti Tauro	10	15
Jayaraj Arokiyasamy	11	15
Erik Valiquette	13	18
Anisha Goel	35	60
Arjun Kalia	8	15
Darshit Shah	13	24
Jayaraj Trivedi	14	30
Anup Chhokar	27	54
Het Vyas	14	21
Goutham Ravichandir	18	30