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Risk Resilient Supply Chain Management using Blockchain Technology

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ABSTRACT

In recent times, Blockchain technology (BCT) has also received considerable attention outside the financial sector. The thought of Blockchain is much beyond than Bitcoin and Cryptocurrencies. Exploring the chances within the Blockchain universe multiple applications of BCT in Supply Chain Management (SCM) are often implemented. During this paper, we shall combine these two perspectives on BCT in SCM to summarize a current state of the art and to derive avenues for further research. This paper aims to investigate the role of Blockchain in sustainable supply chain management and explore the applications which can contribute towards building a risk resilient supply chain.

This paper examines the supply chain management system including the technologies involved and the methodologies. The approach used for making a supply chain monitoring web app through which we can implement a system which makes it easy and efficient to track a product throughout its life-cycle.

KEYWORDS: *Blockchain Technology, Supply Chain Management, Smart Contracts*

I. INTRODUCTION

Supply chain consists of an out-sized number of steps between the origin of the merchandise to the top consumer. Because there are numerous transactions between parties like the supplier, logistics, wholesale, retail and at the top the customer, and since the varied parties maintain independent views of their transaction history there are many issues requiring resolution of disputes. Because a supply chain is often very fragmented, it is often difficult to trace the provenance and/or location of materials within the supply chain. There also are problems with fraud and theft of fabric during a supply chain. Yet, by sharing information securely and reducing risk of tampering, the participants during a supply chain Blockchain powered network are able to do significant rewards in terms of more efficient and accurate transaction processing.

Traditionally, Supply Chain has consistently been upheld the "four Vs": volatility, volume, velocity and visibility and experts had the objective of improving prompts in terms of complete cost, administration quality and backing for development. These needs aren't probably going to fluctuate , yet with the new difficulties of the present relentless world, new advanced advances should build the degree of execution.

E-commerce is setting down deep roots and will continue expanding its significance once established standards for data transfer across the supply chain are figured out.

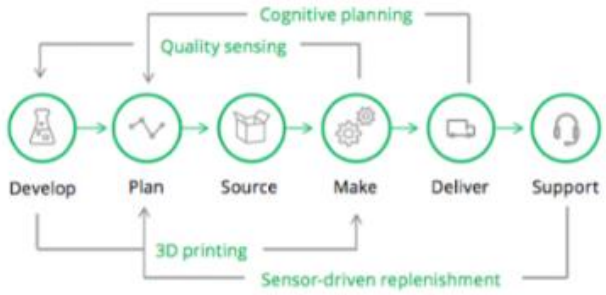

Fig.1 Traditional Supply Chain

II. BLOCKCHAIN TECHNOLOGY

The Blockchain, a decentralized and encrypted digital ledger, was acknowledged together with the highest 10 emerging technologies within the World Economic Forum in 2016. Blockchain may be a sort of arrangement . It is often viewed as a decentralized database during which information are often stored. This database is distributed across all participating nodes, which all agree on a particular set of rules, regarding the allowed behavior within the network and to the structure of the knowledge stored. Blockchain is meant in order that all stored contents are immutable. This enables all nodes to possess access to the ledger as an immutable source of knowledge .

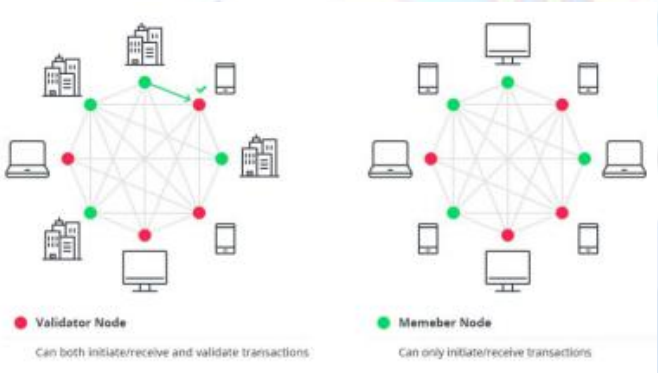

Fig.2 Architecture of Blockchain

Blockchain as the name suggests is made up of two words block and chain, in a sense it is actually a chain of blocks where the blocks are made up of information. The information is the data of transactions which contains the hash key and transaction details. Blockchain is typically a distributed peer to peer open source ledger where each transaction is recorded with digital signatures. Think of it as a distributed database stored in different computers where even if one computer fails the database would still be safe as it's stored on different computers. Blockchain works when transactions take place. The simple process is that first transactions happen then they get verified and the block gets added to the chain. Every transaction occurring in the Blockchain is verified and validated by miners or nodes in the network. Proof of work is the consensus algorithm that is used in Blockchain to verify the transactions in the Blockchain. [2] Now the verification of transactions is like a puzzle where the miners solve the Pow problem whose answer is the hash. Miners use their computational power to solve this and get rewarded in the form of cryptocurrencies etc. When a transaction gets verified the block gets added to the chain. Blockchain is a protocol open source and anyone can view it, the transactions remain anonymous or pseudo anonymous. Blocks usually contain about an average of 500 transactions. Blocks are made up of block header and transactions data.

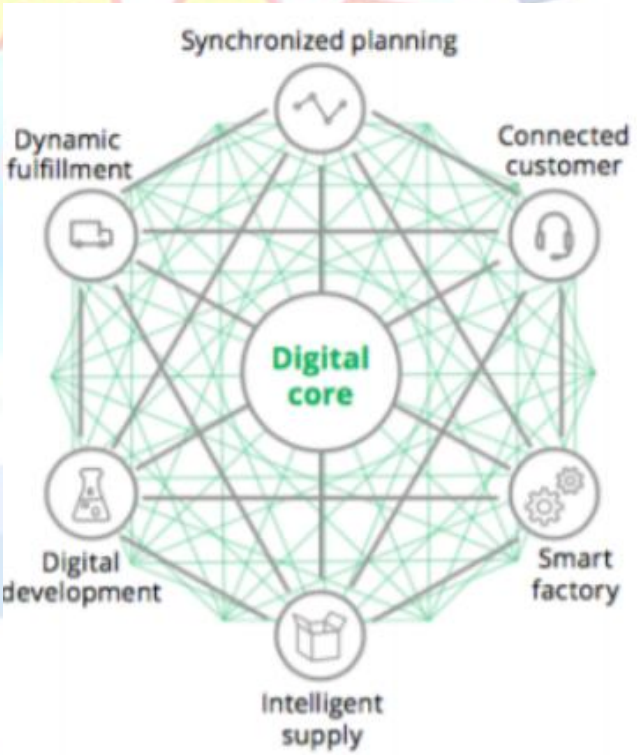

Fig.3 Digital Supply Networks

Not only a digital currency but also a protocol of consensus was created by Nakamoto, the creator of Bitcoin, providing trust even without the central intermediary and dealing on a peer to see network[1]. The protocol is predicated on three basic pillars to supply this trust within the system: decentralization, consensus and cryptography.

III. SMART CONTRACTS

Smart contracts are self-executing contracts containing the terms and states of an arrangement among peers. The terms and states of the arrangement are composed into code. The brilliant contracts executed on the Ethereum Blockchain's decentralized stage. The arrangements encourage the trading of cash, offers, property, or any resource. There are two generally utilized programming dialects for composing Ethereum Smart contracts – Solidity and Serpent. Robustness is an elevated level programming language utilized for actualizing brilliant contracts on the Ethereum Blockchain stage. It enables Blockchain developers to check the program at run-time instead of assemble time[3].

The sheer number of go betweens and halfway layers associated with the execution of a conventional contract eases back the cycle, frequently taking days or even weeks.

Smart contracts can take only minutes, as they are mechanized and programmable, running on a PC under predefined conditions. There are no outsiders included.

Protection and security are worries with customary contracts. With so many middle of the road parties included, security can be undermined at any stage simultaneously. Security is kept up through cryptography, public key, and private keys when utilizing brilliant contracts. Kept up in a decentralized framework, the information is almost difficult to change. Smart contracts are carefully marked utilizing private keys and must be decoded by the public key shared by the gatherings in question.

Terms and conditions are predefined and pre-implanted in a smart contract. When a condition is met, settlement happens consequently and is recorded. In the event that any settlement is associated with a conventional contract, it's a manual cycle including endorsements and work processes. Customarily, straightforwardness is directed by the gatherings in question, fringe substances, and middle people. It's a defective framework. Smart contracts, be that as it may, are 100% straightforward, accessible online 24*7*365. Anybody can survey, review, and approve the documented exchanges. Documenting is troublesome with conventional contracts, as they are paper-based and looked after disconnected. Following exchanges is lumbering. Exchanges in Smart contracts might be followed directly from the purpose of birthplace, and filing happens consequently, making a completely open history. [5]

Conventional contracts are costly when contrasted with brilliant contracts basically on the grounds that every one of those go betweens must be paid. Keen contracts have no go-betweens, and the main exchange charges come from the basic framework of the Blockchain network running the Smart contract.

IV. LITERATURE SURVEY

The difficulties can be designated with the highlights that Blockchain innovation offers. Utilizing Blockchain conventions in the supply chain would mean making a progression of data. A definitive objective is to interface Blockchain to current ERP frameworks, to ensure interoperability. Ventures are now dynamic on this point, for example, Finlync's SAP coordination for receipt of the board and Microsoft's Bletchley[7] .

As per the rules proposed by IBM , the driving standards in embracing Blockchain in a venture are: business plan, innovation outline and coordination. What Blockchain guarantees is to make an organization of significant worth dependent on trust; this will be ensured by the accompanying highlights:

- Consensus: "gatherings to a common truth realize that the reality they see is equivalent to the way that different partners see"
- Validity: calculations are arrangement to assign which refreshes in the framework are substantial
- Uniqueness: there is just a single rendition of the reality, there can be two legitimate updates yet on the off chance that they struggle, just one will be worldwide conceded to in the organization
- Immutability and Authentication: information can't be changed and each activity is made sure about with a key – there is no director account that has more force [11]

Among the assortment of Blockchain advancements that are now set up and applied in various regions of business, coming up next are three of the most popular ones. Each Blockchain has distinctive specialized qualities, subsequently

unique application alternatives and advantages. For this situation study, we will think about the attributes of Hyperledger Fabric, Ethereum and Corda Blockchain options to survey which one would be more useful to supply chain the board applications.

Example use cases

Case 1 - Walmart

IBM has cooperated with a Consortium of food organizations including Unilever, Nestlé, Walmart and Kroger to advance sanitation. Walmart had just embraced Blockchain already and is currently stretching out the innovation to the entire consortium. The fundamental objective is decreasing expenses and timings of reviewing perilous food clusters. The underlying speculation to move all information to a Blockchain and make new more straightforward principles to facilitate the following cycle is legitimized by the cost reserve funds and the brand mindfulness that follows. In food Supply chain, with regards to wellbeing, there are three primary costs that retailers face: human loss of wellbeing and life (as per the WHO 420 thousand individuals kick the bucket on normal every year because of food contamination), the expense of reviewing a spoiled decent, that relies upon the maker and the volume of deals, and the general misfortunes in deals of the item, even from different makers. These last expenses are assessed to be, just in the US, from $4.4 billion to $93.2 billion every year.[9]

Case 2 - Nepcon

NepCon is a global non-benefit association that has been dealing with practical land utilize and mindful exchange of woodland products for as far back as 20 years. Its contextual investigation was introduced and utilized during a Blockchain Summer School in the University of Copenhagen in August 2017 (xv) and unraveled because of the use of Blockchain innovation. The contextual analysis is identified with the Supply chain of wood, from the woodland to the last buyer after change in a wide range of items. It is a genuine case of how Blockchain can be applied to comprehend discernibility issues and keep up a strong information joining along all hubs in the Supply chain. In the particular instance of NepCon, the principle challenge is to have the option to follow the lumber along the graceful chain, to confirm that unlawful exchange isn't sold under the FSC Certificate. The multifaceted nature of the Supply chain makes starting makers and the accreditation authority forget about the absolute affirmed volume. The yield of guaranteed wood is, indeed, more noteworthy than the contribution, as demonstrated as follows.

The arrangement proposed throughout the Summer School is a private Ethereum Blockchain that can uphold the volume compromise. This is finished by relegating a particular token as an advanced portrayal of the actual resource "confirmed wood" (1m3) on the Blockchain. This is empowered by Smart Contracts and results in the capacity to control that the underlying volume of guaranteed wood is kept up along the change. The figure underneath shows the progression of the tokens in such a framework. In the last hub of the Supply chain, it is conceivable to confirm the responsibility for tokens that were moved to the accompanying hub of the graceful chain as affirmed wood was being sold and changed. The general volume of tokens is consistent and is possessed simply by those that utilized affirmed wood.

This contextual investigation prompts dissecting a basic component of applying Blockchain to SCM. While speaking to actual resources with advanced duplicates, we experience the problem of the "computerized twin". In the NepCon case, for example, the general volume can be controlled, yet the truth is more intricate.[12]

V. METHODOLOGY

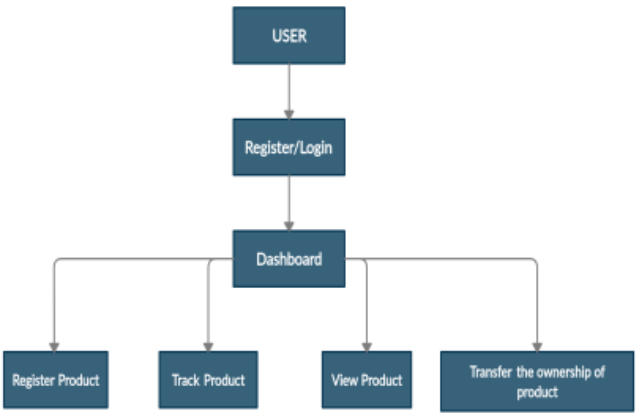

Fig.4 Data Flow Diagram

Creating Smart Contracts using Solidity

Smart contracts are the backbone of the Blockchain, which enable us to make the

Blockchain according to our needs. To write Smart Contracts, an Object-oriented language is used called solidity. For this project to write the Smart Contracts, an online IDE called RemixIDE is used.

In the Smart Contract we write all the operations that need to take place in the Blockchain, everything from creation of a new block in the chain, how we will access the blocks, everything can be handled by writing functions in Solidity.

Fig.5 Designed smart contract (2)

A file named productChain.sol has been created in order to create the Smart Contract. In this file we have written functions respective to the different stakeholders i.e. Manufacturer, Distributor and User.

As a new block is added in the chain it is initialized and allotted a unique ID which helps us in identifying what every block in the chain signifies.

A structure is created with a name track which consists of productid, owner_id, and owner address. We use this structure in different methods throughout the code in order to track the product in the chain.

Methods named setProduct() and getProduct() are created in order to add new products in the system and to access those products respectively.

All of the methods in the program perform necessary checks in order to make sure the right stakeholder is able to perform the task they are supposed to and the other stakeholders are not able to perform those operations.

Like in this case of adding a new product using setProduct(), a check is performed before adding a new product to make sure that only manufacturers are allowed to add a new product.

The ID by which the product is initialized is mapped to products[ ], and for each productID the following information is added for each product:

- Type
- Name
- Address of stakeholder
- Specifications

Fig.6 Designed smart contract (2)

The above piece of code shows the operations that are handling the operations related to the stakeholders. The ID allotted is mapped to stakeholders[ ], which store the following information with respect to each id:

- Name
- Password
- Address
- Type of User

This information is further used and verified in order to login each stakeholder and determine what access they should be given and what operations they can perform depending on the type of the user.

The method transferOwnershipOfProduct() is created in order to transfer a product from one stakeholder to another, as the product moves in the Blockchain. This function takes two user IDs of different users and performs the operations required for the transfer which will be different for the two possible cases as per our system:

- Transfer of ownership from manufacturer to distributor
- Transfer of ownership from distributor to user

The following methods are implemented in server.js:

- setstackholder
- loginstackholder
- regmobile
- track
- transferowner
- mobiles
- getstakeholder
- Getmobile

VI. RESULTS

The designed system makes it easy to monitor the product throughout the supply chain starting from the manufacturer all the way to the consumer. The products can be associated with a unique identification which can be easily read like a QR-code which will allow us to update the chain at every step as the product moves and it will be easier to track and identify any problems arising between the flow.

The following result shows the identification of each product along with the progress of the product at each stage of the chain.

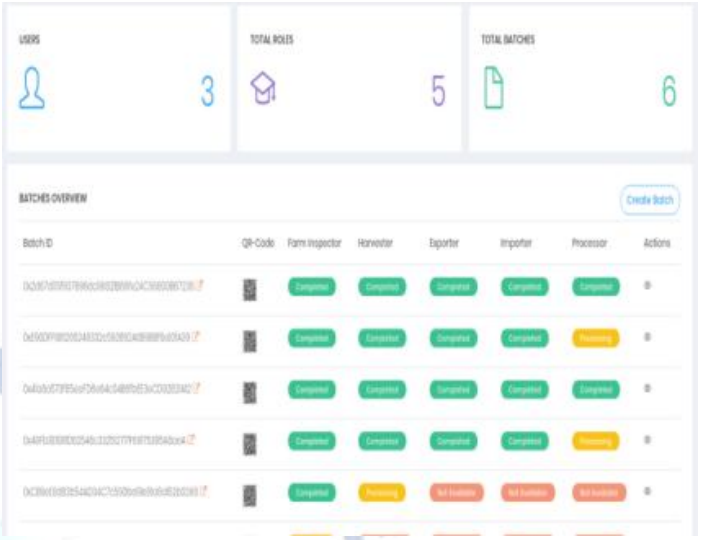

Fig.7 Application dashboard

There will be separate dashboards for users at every stage displaying the information necessary to them and the admin dashboard will have access to all the information about a product and some control over who is able to view the information as well as addition and updation of users as well as products.

It lets us verify the time-stamps of various activities of the product at every single stage and makes it very easy to monitor any risks.

VII.CONCLUSION

In this report we have explained a supply chain management system using Blockchain. We have explained the technologies and the methodology behind it. The upside of this system is the transparency and security throughout the cycle of the product. Unlike the traditional systems Blockchain provides added security. Currently, the designed system is confined to a simple chain involving a few stages but this system can be used as the basis for more complex supply chain management systems on Blockchain. The possibilities in this area can be widely explored to make the current SCMs more efficient and reliable by redesigning and implementing them using Blockchain.

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