Traceability of Pharmaceutical Drugs throughout the Supply Chain using Blockchain

Anita Kanavalli, Parth Venkatesh, Shiv Dutt Tripathi, Shubham Kumar, Adi V Chari

Abstract: The pharmaceutical industry is prone to many risks and the effect of these risks propagating to patients is enormous. Just like other sectors, the pharmaceutical sector can also benefit from new methodologies in the supply chain network. More effective supply chain management can benefit the pharmaceutical industry by reducing the risks from the current challenges being faced by the industry. Difficulties like missing interest data, human asset reliance, request of the board, distribution center administration, absence of coordination, shipment perceivability and lapse must be confronted. An important observation from these challenges is their dependence on human resources to come about these changes in the state and process information. Inevitably, blockchain can construct the profitability and straightforwardness of flexible chains and vehemently influence everything from warehousing to movement to portion. The core benefits of the blockchain technology are Immutability, Corruption & tamper proof, Secure and Zero downtime. These make the blockchain technology a very effective means for revolutionizing the supply chain management

Keywords: Blockchain, Pharmaceutical Supply chain, web3JS, ganache, ethereum, truffle, solidity, encryption.

I. INTRODUCTION

Indian medicine industry is the 3rd largest in the world. It is growing each day. It is the 11th largest exporter of medicine in the world. WIth the emergence of the global era, it is very prime for the medicines to be authentic. The exporting company should keep track of everything related to the medicine, from the supplier of the raw materials to the supplier and distributor. All the tracking of materials that is done is mostly done on paper, that is, a hard copy of the details is maintained. This poses a problem to synchronisation and authenticity of records. Since the data is maintained offline, tallying of the data cannot be done properly. Also one can manipulate the manual records later on and lead to scams. There are also some companies that maintain the data online. These help in tallying the data and allow synchronisation and authenticity of records. However, they have their own problem of privacy. The records are maintained online and are available to everybody. This leads to privacy concerns.

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To address the above, we need to have a framework wherein data is stored online so that it is authentic and one can tally the entire data. Along with this, the framework should store the data in a way that it is publicly available but does not invade privacy of users.

The solution to such a problem is not really new. It was conceptualized in 2008. However, it is still considered to be a fairly new technology because it is not used a lot. We propose a system built using blockchain. Blockchain is a service that works with blocks called nodes. It has really long chains of nodes and each node represents some object. Each chain represents an object , and the nodes in the chain contain data about the state of the object at various points of time. This helps in tracking the whereabouts of a product right back to its source.

Along with this, blockchain comes with an inbuilt feature of encryption. Data that is stored in the nodes is encrypted with a hash value. All the stakeholders are identifiable by an encrypted hash value. This puts away various privacy concerns.

In the paper below, we put forth our approach to our application and results obtained at the completion of the project.

II. RELATED WORKS

Perusing important writings identified with blockchain innovation implied perusing ongoing papers from the various diaries which were very later as the blockchain upset is very new to strike the gracefully chain the executives. Gracefully fasten the board should have been overviewed to get a comprehension of how the flexibly chain the board functions in the pharmaceutical business. Walmart is explicitly utilizing the Blockchain innovation for detectability in food items so the shopper can follow the starting point, crude materials utilized and the procedure the item has experienced (IBM, 2018)[1]. IBM for sanitation in the flexibly chain: 1 decrease in misrepresentation, 2. Improved flexibly chain proficiency, 3. Expanded trust of the shopper, 4. Lower stock and messenger costs. Blockchain development is seen as a potential technique to improve the security and cost sufficiency of coordinations trade .Moreover, blockchain advancement is used to develop blend over the web and can be understood as a many-to-various blend appear, sent all in all general public cloud to coordinate tied down trades rapidly and easily . To develop an away from of blockchain plot norms and functionalities, the current examination is grounded in a composing overview and gatherings with all inclusive pros in blockchain advancement [2].

Apply that equivalent security and excess to something like stock, and substitute flexibly chain accomplices for banking hubs, and you have the establishment for a profoundly new way to deal with gracefully chain the executives. The utilization cases for this better approach for working are convincing. At its most essential level, the center rationale of blockchains implies that no bit of stock can exist in a similar spot twice. Move an item from completed products to in-travel, and that exchange status will be refreshed for everybody, all over the place, in practically no time, with full detectability back to the point of origin[2].

Blockchain Innovation offers associations the decision of decreasing inside organization costs and growing profitability by advanced izing or overseeing power through digitalization of external frameworks. In a word, blockchain development through its cutting edge viewpoint is that the firm oversees on trade costs through the assurance of internal organization costs for managing exhibit trade costs. Advancement fixates on where a trade occurs and when items, organizations or information are traded across over activities and systems. All around structured interfaces enable this trade to happen without any problem. Overall trade practices normally incorporate an extent of business frames across over legitimate guests. Data demonstrated ought to be made in a way that the information stream can be traded electronically and to grapple interoperability inside systems, as discussed in the electronic data compromise composing. A key feature of blockchain development is that it keeps up an open passed on record of trades without perceiving social affairs to the trade. Likewise, the record is copied to all center points of the framework. If a trade is changed, another square is made and attached to past squares. Record data between center points of the blockchain are composed aimlessly intervals. Therefore, there is no explanation behind breaking into the record, as the data is starting at now open and bars information about the characters of the social affairs or their ledgers. Whether or not one could break into the record data and change a trade or incorporate another, planning of the record data between center points of the framework would refute such changes as invalid record trades. Meanwhile, the merchant may enlighten the buyer regarding the trade and check its existence from individuals as a rule. This blockchain feature may remotely appear an imperative departure from current practice, where the characters of trader and buyer are known. Moreover, an ordinary business trade incorporates two sections: an open record segment about the trade and private messages between the social affairs about their characters, with security keys for trade data and region. Solidifying these makes it possible to evade the need to trust in pariahs and to execute the trade rapidly expecting practically no exertion. The beginning party and coordinations base record exchange need to prompt the other party about the nearness and exchangeability of files, using open key structure data. The initiator of trade sends the other party a touch of programming to unscramble and scramble SCM achievement identifiers associated with the records exchanged. If the tolerant party ignores this single key security message, the trade must be repeated. This makes another blockchain section and another security

message. The course of action depends after solidifying open private keys.

Everybody wants to detest mediators, yet it turns out they are extremely valuable. Until the approach of bitcoin and blockchain innovation, the main way you could get an enormous number of elements to concur upon a mutual, honest arrangement of information, for example, who has what bank balance, was to name a fair-minded delegate to process and record for all exchanges. Blockchains make it feasible for biological systems of colleagues to share and concur upon key snippets of data. In any case, they can do it without designating a middle person and manage all the mind boggling exchanges and strategic maneuvers that accompany setting the principles before giving over extremely basic business data. Rather than having a focal mediator, blockchains synchronize all information and exchanges over the system, and every member confirms the work and computations of others. This tremendous measure of repetition and crosschecking is the reason money related arrangements like bitcoin are so secure and solid, even as they synchronize countless exchanges across a huge number of system hubs consistently. The additional straightforwardness offers evidence about how merchandise were sourced and how they agree to guidelines.

After a prescription is pushed, an absolutely exceptional game plan of objectives, drivers, and confinements become transcendent. The key accomplices in the smoothly chain fuse diverse government workplaces, crisis centers, offices, cure creators, quiet shippers, tranquilize store chains, retailers, investigate affiliations, and the FDA[4]. Blockchain advancement is a database structure at first proposed to oversee exchanges the Bitcoin cash. Blockchain portrayal made by Nikolai Hampton (2016) stressed that blockchain can be thought of as a physical book, where each page contains around ten minutes of exchanges Bitcoin or Ethereum Cash [3]. At the point when a page is done off with new exchanges the opportunity has arrived ventured, set apart with an uncommon consecutive number, and stuck into the book. Thus, the pages address squares additionally; the se-rial numbers address the association between the squares. The sequential number is a consequence of the trades in that page, and the sequential amounts of close by pages are darted together through a numerical limit, molding a solid chain of pages. This makes it hard to transform one of the trades without changing the sequential number of that page and along these lines ending the association between that page and the going with page .

III. METHODOLOGY

The Method Used for developing secure supply chains which are immutable and have a private network with authentication users, only those users are allowed to make a transaction who have the private key and can perform digital signature by a trusted authenticator, **Ethereum Blocking Network** is being created dynamically for new contracts on which the stakeholders can deploy the contract and perform a secure transaction and it returns a unique hash code.

Each node of the block chain contains two parts one is Block header and second is data. Note the hash value created from this is by using the content of data, so if content of data is being manipulated the hash value will also get changed and will not be able to retrieve the transaction details , all nodes in the blockchain are immutable and data between the blocks remain consistant. Since all the stakeholder have their own public and private key ,so change of making a transaction through unauthorized person reduces bcz they don't have the private key to decrypt, Registering shipping and Tracking details can easily be perform through browser using **REST API** calls which internally connected to the ethereum based blocking network thorough web3js, through api call one can easily register and perform a shipping operation. In order to interact with the blockchain node from the front end UI build with (**HTML5,CSS,Bootstrap,JavaScript**) should be connected to the rpc server listening on some port(e.g **localhost:8545**) on **Ganache**.
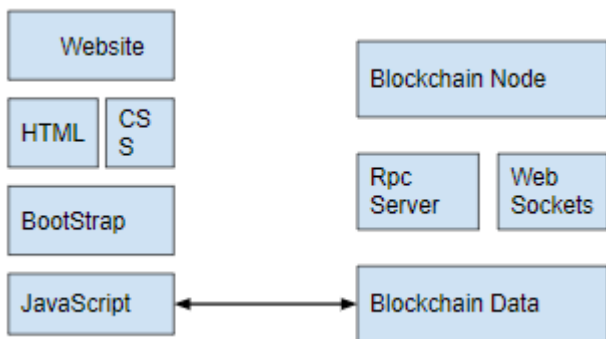
Fig 1. System Design of the Model

IV.   IMPLEMENTATION

Before Jumping right to the Implementation of Pharmaceutical supply chain management system, our assumption is that authorized persons at each level of the chain are not sharing the private key required to make a transaction in the blockchain. Here we are considering 4 stakeholders(Supplier,   Manufacturer,   Distributor, Pharmacists) who all are actively involved in making transactions through the blockchain Encryption system. First Supplier should have all the product items required to manufacture a specific drug , then the supplier will add all the information required like (product id, Product Description, Farmer Name, Farmer Location, Quantity, Shipper , Receiver, timestamp) into the blockchain and blockchain will generate a unique hash value which will be required for traceability or tracking of the transaction starting from Supplier to all the way to Pharmacists. First drug will be ship to Manufacturer(Where the drug will get Manufactured from the products got from farmer's) here Extra info can also be added to the blockchain like live location, timestamp (how much time it took to deliver the product) of logistic service providers so that in case of any fraud or counterfeit , We can trace back through transaction hash id and find the exact victim. once the Manufacturer received the product items required to make a drug he/she will first verify the item and also be able to check the origin with the help of transaction hash id and their secret private key ,here validation at each level of supply chain is required by the stakeholder,. after this Manufacturer will send the Drug to distribution and add certain info like (Manufacturer Description ,Pick & Pack, Quantity, shipper, Receiver, Receiver type) into the blockchain using their unique secret private key. same for Distributor and Pharmacists , Pharmacists will validate the drug and can also check the transaction through unique hash transaction id saved on blockchain , if any dealer try to sell a counterfiet drug to Pharmacists using fake id, then the transaction will be considered as Invalid. Architecture of the model is shown in Fig 1.

Tools used in building up the supply chain:
    Frontend - HTML5,CSS,JavaScript,Bootstrap
    Backend - Node js
    Blockchain- Web3.js, Ganache-cli, Truffle,
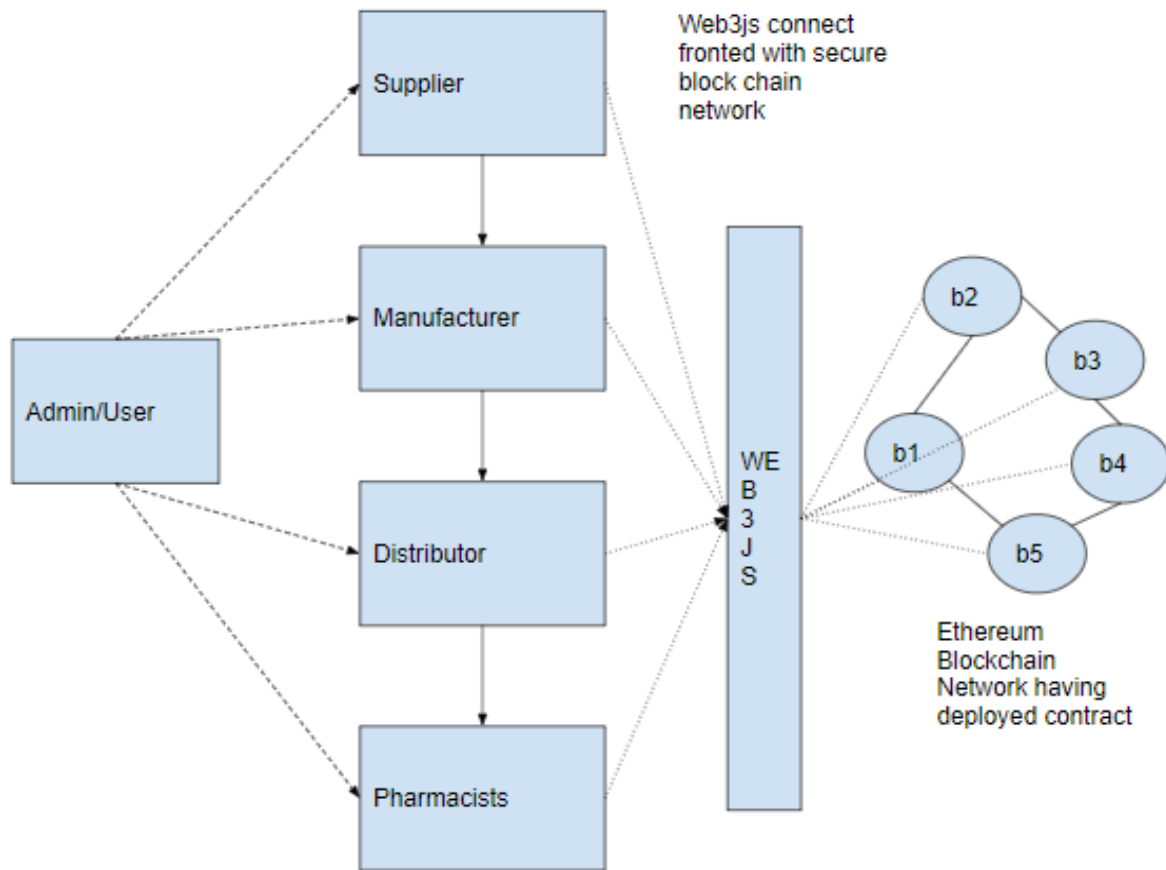   Metamask,Solidity

Fig 2. Architecture Diagram of the Model

V. RESULTS

There are three aspects to the application developed for the implementation of the project. The first part being the realization of a medicine factory which is responsible for producing the medicines. The factory will manufacture the medicines and supply them to the packaging factory.

The second aspect of the project is the packaging factory which will make bundles of the medicines and supply to the dealer.

The third and the last aspect of the project is the dealer. The dealer being the one needing all the whereabouts of the medicines is able to check the same.

To start the ganache client we use ganache-cli command and the result is as depicted in the image:

The above image depicts the ganache client is now listening for transactions. Any transaction made will append block to the blockchain. Ganache is an emulator, which means it makes an artificial blockchain which can be used to develop easy and quick applications much like the one developed here.

The mnemonic can then be used on the metamask browser extension to track the wallet. The transaction can then be performed using the smart contract that includes three important instructions:

1. The recipient's address.
2. The amount to be transferred.
3. Protection against replay attacks.

Replay attacks must be avoided as these can lead to multiple transactions being performed in place of the user. nonce is used to get safeguard against these.

Ethereum smart contracts are inherently safe but nonce is required so that a signed transaction is not replayed.

The web server can be run using the http-server command and the result of the following is the three aspects of the project as depicted in the images:
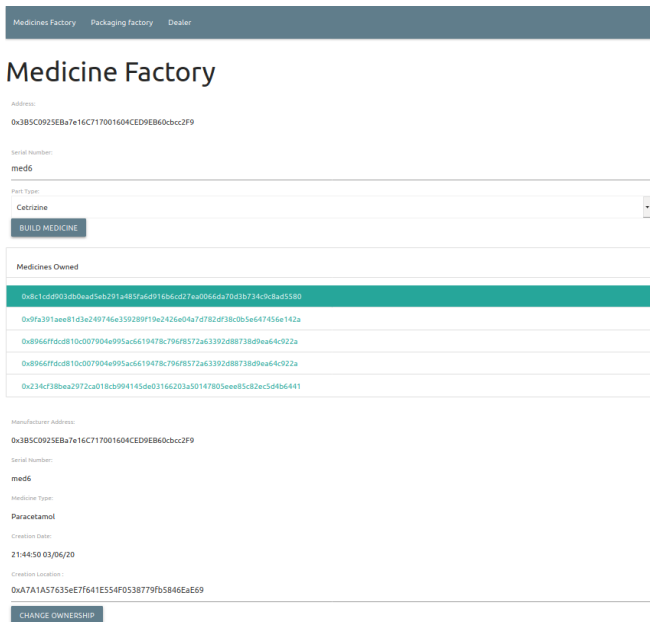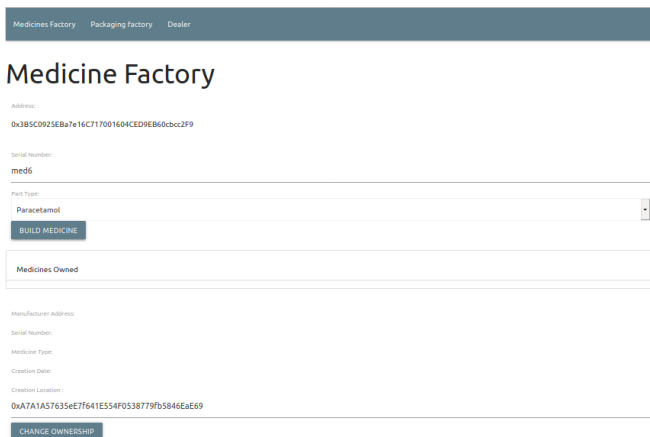
The above images shows the working of the medicine factory which is responsible for the manufacture of the medicines. A transaction is recorded in the ethereum contract and the packaging factory gets the medicines and starts working on the after route for them.
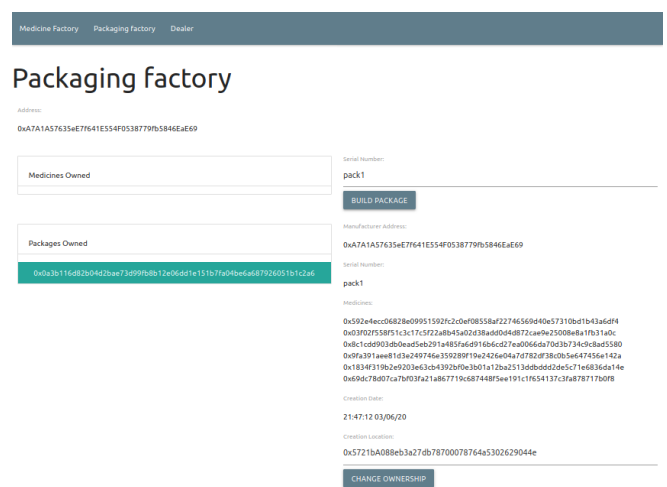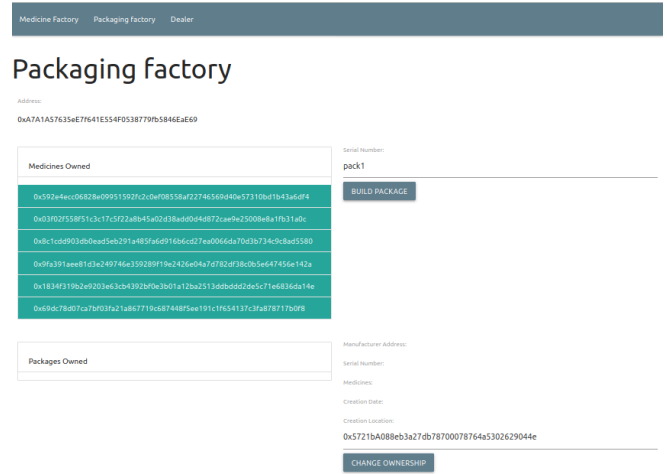
The above images depict the behaviour and working of the packaging factory. the factory is able to receive the transactions related to the products and packs 6 medicines in one package to deliver the same to the dealer.

The noticing factor in the transactions is that they cannot be tampered with. Being in nature a chain of blocks which are immutable the transaction flawlessly records the transactions and stores the whereabouts of the medicines. The traceability of the medicines and their packages can then be easily realised.

There can be a condition where two blocks are heard by the chain who share the same code. This problem is solved in the original paper written by Satoshi Nakamoto. The longer chain that transmits will remain in business because guessing the hash code once is possible but keep guessing it correct all the times is impossible and that is why this technology works.

Ethereum is an excellent cryptocurrency platform featuring the smart contract functionality which can be entrusted for the working of this project. The platform is open source which provides the ability to come up with applications like these.

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The above is the final aspect of the project which results in the dealer being able to trace all the whereabouts of the transactions related to the medicines as well as their packages.

VI.   CONCLUSION AND FUTURE WORK

Blockchain innovation is a problematic computerized innovation which is equipped for supporting existing procedures and upsetting existing plans of action. Blockchain-empowered arrangements help fabricate trust, straightforwardness and recognizability. In this paper, we give a short prologue to the Blockchain innovation and portray how it very well may be applied in the pharmaceutical business. We give one understanding of Blockchain in the pharmaceutical flexibly chain in this paper. Blockchain innovations are still very youthful and it is difficult to state with precision whether they will flourish later on because of a significant number of their calculated confinements. Be that as it may, such investigations, as an arrangement of power over the course of medications, can later turn into a model for the development of further developed answers for mechanizing the procedures of the state mechanical assembly with the greatest degree of data security on the preparing of information

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