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Traceability of Counterfeit Medicine Supply Chain Through Blockchain

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***Abstract*—The main issues with drug safety in the counterfeit medicine supply chain, are to do with how the drugs are initially manufactured. The traceability of right and active pharmaceutical ingredients during actual manufacture is a difficult process, so detecting drugs that do not contain the intended active ingredients can ultimately lead to endconsumer patient harm or even death. Blockchain's advanced features make it capable of providing a basis for complete traceability of drugs, from manufacturer to end consumer, and the ability to identify counterfeit-drug. This paper aims to address the issue of drug safety using Blockchain and encrypted QR(quick response) code security.**

***Index Terms*—Blockchain, Drug safety, medical supply chain**

I. Introduction

World Health Organization (WHO) defined counterfeit medicine as "one which is deliberately and fraudulently mislabeled with respect to identity and/or source"[1]–[3]. Counterfeiting of various products creates problem to different manufacturing industries and it causes serious threat to pharmaceuticals products. This threatens the public health and also causes revenue loss to the legitimate manufacturing organizations. The International Chamber of Commerce of Geneva reported that the annual sales of counterfeit products in the world amounts to U.S.$ 650 billion [4]. There are various techniques which has been already used for tracing counterfeit drugs in medical supply chain. Authors in [6], proposed usage of Smart-Track which contains bar code or RFID code on medicine bottles for verifying its legitimacy. Similarly, Data-Matrix tracking system has been proposed in [7], where each medicine contains a Data-Matrix. This matrix includes Manufacturer ID, Product ID, unique ID of the package, the authentication code and optional meta -data. The author has also mentioned the CVR(central verification register) which will store the hash value of the details included by Data-Matrix. On purchase scanned Data-Matrix (which includes hash value) is verified with CVR of the manufacturer.

Authors in [8] has proposed a NFC (Near Field). (Near Field Communication) tag. A key exchange technique has been proposed to verify the details of the medicine from its NFC tag [8].

None of the above methods use the automatic verification of product authenticity, and manufacturer legitimacy. When it comes to preventing counterfeit drugs in the drug supply chain, blockchain technology stands out as a way to ensure an immutable chain of transaction ledger, tracking each step of the supply chain at the individual drug level [5].

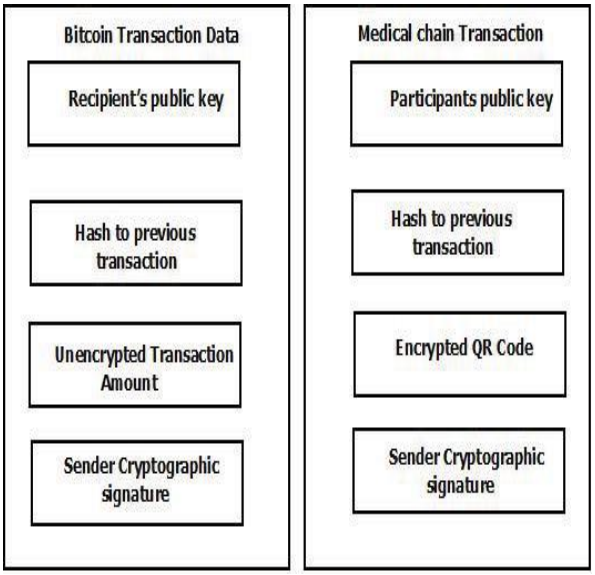
Motivation:-The counterfeiting of medicines causes the serious threat to the society. The counterfeited medicines make an adverse effect on the health of the people and also cause revenue loss to the legitimate medicine manufacturing organizations. In the recent years, several anti-counterfeiting techniques have been proposed. However, most of the existing schemes are not secure and are prone to various attack such as replay, man-in-the-middle attack. Although conventional technologies, such as RFID, barcode scanning, and mobile technology, have been applied for tracking and tracing of medicines, counterfeit medicine is still significantly high. To overcome these various attack and counterfeit drug safety, we have proposed encrypted QR code techniques which will be only accessed by the authorized body that is approved by regulatory authorities of medical supply chain.

II. Proposed Framework

In this section, we have proposed Medical chain storage using permissioned blockchain and how counterfeit drugs will be tracked.

A. Medical Chain Data Storage in Blockchain

The proposed structure for storage of transaction data, shown in Fig-1, represents the similarity with Bitcoin transaction data. As shown in Fig-1, each participant will share their public key, hash value of previous transaction, encrypted QR (Quick response) code by manufacturer. The QR code consist the details of medicine which is manufactured by pharmaceuticals agency. The transaction of medical chain here is secure and tempered-proof. Illegitimate participant can't get access to the block of transaction due to public key verification of participant (recipient) and digital signature of sender. This structure provides the non-repudiation verification using the sender cryptographic signature. The given structure also prevents the double spending problem because of QR code. Each transaction of block in blockchain will contain an unique QR code, which cannot be reused by the manufacturer for different medicine.



verification Fig. 1. Medical chain storage for drug safety

B. Drug Safety using blockchain

The proposed framework for drug safety using blockchain is shown in Fig-2. It produces the secure channel for drug safety among various participants like Manufacturer, Distributor, Patient, Hospital, and Regulatory of smart contract, in medicine supply chain. As shown in Figure-2, each transaction data includes manufacturer and its product information, e.g., manufacturer-id1(MID1) has manufactured Drug-ID1 (DRUG1) and Drug-ID2 (DRUG2). This data is known and distributed to all participants in medical chain framework. This structure shows here transparency between the participants.

The following steps are involved for drug safety

1) In proposed framework, pharmaceuticals organization will manufacture the drug with details such as drug name, location, timestamp, ingredients, usage of drug, and side effect and get authorized by regulatory approved smart contract. Manufacturer generates an encrypted QR (quick response) code for the details and attaches the transaction to the blockchain system.
2) If any participants want details of drugs, then public key must be shared by that participant to the manufacturer. Manufacturer will encrypt the QR code and will send back to the participant.
3) The QR code will be decrypted by the valid participant by their private key.

The methodology for proposed work is shown in Fig-3 which is

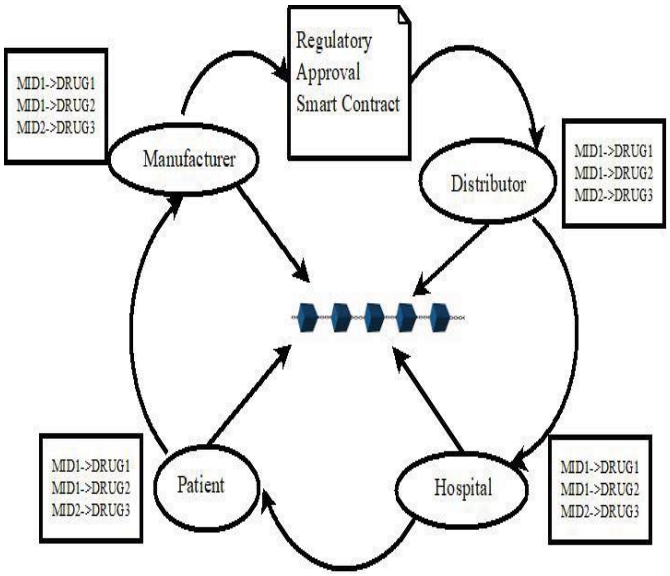


Fig. 2. Medical chain supply using Blockchain

4) The illegitimate user can not access the blockchain, only legitimate can access the blockchain using public key.

C. Methodology for Proposed Work

based on private Blockchain technique ,where all the authorities has to get the membership by provider(Regulatory Body) and digital signature by certificate authority.The digital signature will be provided by the certificate authority , hence the participants can trust on it.

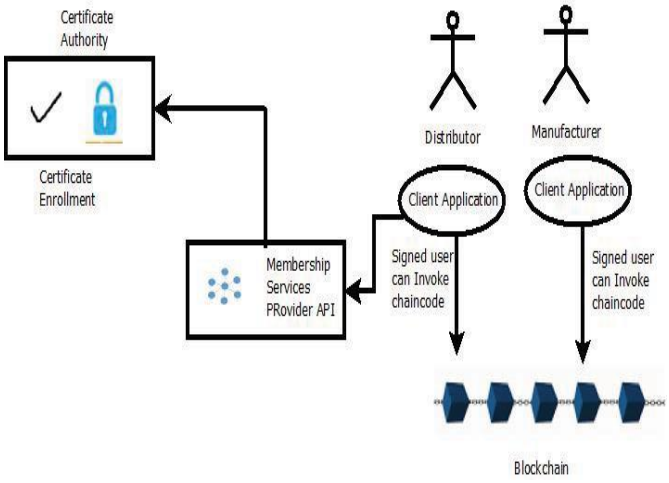


Fig. 3. Work flow of proposed work

The following steps are involved during transaction in drug safety

1) Transaction between participants will consist sender public key and digital signature, receiver public key and the information which is sent by sender.
2) The shared information between the participants will be in encrypted QR code format , which can be only accessed by receiver public key.
3) Sender public key will be verified by all the participants of medical chain supply.
4) Once the transaction get committed then it will be distributed to all the participants.

III. Conclusion

The proposed Framework represent blockchain based secure infrastructure for medical chain supply among valid participants. The mentioned framework can provide drug security as well as authenticity of manufacturer. The Current medical chain framework is working on third-party trust which is not very secure for the drug safety. The proposed methodology based on PKI and digital signature which can prevent from replay and man-in-middle attack.

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