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Traceability and Detection of Counterfeit Medicine Supply Chain through Blockchain

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ABSTRACT: The production and distribution of counterfeit drugs is an urgent and increasingly critical worldwide issue, especially in developing countries. The market value of pharmaceutical counterfeiting has reached billions of dollars annually. One of the reasons for drugs counterfeiting is the imperfect supply chain system in pharmaceutical industry. Drugs change ownership from manufacturers to wholesaler, distributor and then pharmacist before it reach the customer. In current supply chain system, information is not shared between systems, manufacturers don't know what happened to their products, drugs regulatory authority has no visibility of the system, recalls are complicated and costly, and companies cannot follow-up patients. In this paper we explain how to use block-chain technology in pharmaceutical supply chain to add traceability, visibility and security to the drugs supply system. The proposed system will be used in pharmaceutical industry to track the drugs from its manufacturing until its delivery to patient. After the usage of a drug, its effect on patient will be recorded to a database for future statistics. A permission block-chain will be used for storing transactions and only trusted parties will be allowed to join the network and push data to block-chain.

KEYWORDS: Block chain, counterfeiting, supply chain management, pharmaceutical industry, traceability, security.

I. INTRODUCTION

Pharmaceutical Research & Development is a complex process that takes several years from drug discovery to drug development and regulatory approval. When all the process is done and a standard product is developed, the next challenge for manufacturers is to deliver the product to the intended customer in its original form and to ensure that the customer get the genuine product that is developed by the legitimate manufacturer, not by counterfeiter. But the current Supply Chain Management (SCM) system of pharmaceutical industry is outdated, and doesn't provide visibility and control for manufacturers and regulatory authority over drugs distribution and it cannot withstand the 21st century cyber-security threats. This situation of SCM leads to the production, distribution, and consumption of counterfeit drugs. Counterfeit drugs have created a particularly dangerous public health risk and increasingly keen worldwide issue especially in developing countries.

These counterfeit drugs directly and indirectly adversely affect health. Indirectly, these drugs do not contain the dosage or active agent required to kill the disease, that finally cause drug-resistant strains, and then even using the original drugs are useless. More directly, such counterfeits may contain active ingredients, but the amount is too low or too high, or produced in an impure manner that contains toxic ingredients, in this case it can cause very serious health problems. Counterfeit drugs manufacturers sometimes use the brand logo of legitimate manufacturers and make fake products used in daily life, that's less harmful. But in many cases they affect the drugs for the treatment of cancer, painkillers, cardiovascular disorders, antibiotics, contraceptives and other prescription drugs that can lead to very serious results.

According to the International Anti-Counterfeiting Coalition (IACC), counterfeiting has become one of world's largest and fast growing criminal businesses, with an estimated value of more than US\$ 600 billion annually.

For the prevention of counterfeit drugs, pharmaceutical industry needs an efficient supply chain management system, and the best available solution to develop a perfect SCM system is the Block-chain technology. Block-chain is a distribute ledger system (firstly introduced by a pseudonym Satoshi Nakamoto in 2008) that has shown widespread adaptability in recent years and a variety of market sectors sought ways of incorporating its abilities into their operations. Although, so far most of the focus has been on the financial services industry, but now projects in other service related areas, such as healthcare, energy and legal firms also started using this marvel. Supply chain security is one aspect that has recently won

attention. Any product subject to a sensitive production process and widespread reputational issues are associated with the final product, the benefits of Block-chain are evident. Block-chain is the best fit in those scenarios where privacy protection and data security is the highest priority. Therefore pharmaceutical supply chain presents a further use case of Block-chain technology.

1.1 Motivation

- Pharmaceutical companies face many challenges regarding counterfeit medicines.
- Detecting fake medicines in order to save public life.

1.2 Problem Statement

To design system for traceability and detection of fake medicine supply chain using blockchain which provides traceability of drugs from manufacturer to end consumer and detection of manufacturing process of medicines to overcome drug safety issue.

II.RELATED WORK

Literature survey is the most important step in any kind of research. Before start developing we need to study the previous papers of our domain which we are working and on the basis of study we can predict or generate the drawback and start working with the reference of previous papers.

In this section, we briefly review the related work on Traceability of the Counterfeit drugs and their different techniques.

In this paper, we suggest Gcoin blockchain as the base of the data flow of drugs to create transparent drug transaction data. Additionally, the regulation model of the drug supply chain could be altered from the inspection and examination only model to the surveillance net model, and every unit that is involved in the drug supply chain would be able to participate simultaneously to prevent counterfeit drugs and to protect public health, including patients. With Gcoin blockchain, the governance model of the drug supply chain could shift from regulating (only by government audits) to surveillance net (by every participant who involves the supply chain).[1]

In this paper, the author uses the internet which is facilitating the trade by providing counterfeiters with a large consumer base and limited risks. The dark net within it allows for anonymous transactions between manufacturer, distributor and consumer. While some online pharmacies are legitimate, there are a growing number of those that are unverified which sell dangerous counterfeit products. Both the packaging and medication are becoming increasingly sophisticated, making it difficult for consumers and law enforcement to identify them without chemical analysis. Counterfeit batches have also been detected in established legal trade routes whereby they are able to, if undetected, end up in high street pharmacies and hospitals. Multiple organizations have set up worldwide operations to dismantle the trade however this is a complex and evolving problem that without significant changes to legislation may never be fully.[2]

In the paper, the author propose a medical data sharing and protection scheme based on the Hospital's private blockchain to improve the electronic health system of the hospital. Firstly, the scheme can satisfy various security properties such as decentralization, openness, and tamper resistance. A reliable mechanism is created for the doctors to store medical data or access the historical data of patients while meeting privacy preservation. Furthermore, a symptoms-matching mechanism is given between patients. It allows patients who get the same symptoms to conduct mutual authentication and create a session key for their future communication about the illness. The proposed scheme is implemented by using PBC and OpenSSL libraries. Finally, the security and performance evaluation of the proposed scheme is given.[3]

In this paper, the author presents a systematic mapping study in order to map out all relevant research on SCM based on BCT. The paper took a survey on other blockchain applications in SCM that need additional investigation, such as agricultural supply chain, security of additive manufacturing, product ownership management, common-pool resource management, purchasing and supply management, supply chain quality management, supply chain performance measurements. Nevertheless, many of the proposed frameworks-based solutions lack real performance evaluation on the industrial context.[4]

In this paper, the author propose an innovative blockchain-based IIoT architecture to help build a more secure and reliable IIoT system. By analyzing the shortcomings of the existing IIoT architecture and the advantages of the Blockchain technology. we decompose and reorganize the original IIoT architecture to form a new, multi-center, partially decentralized architecture. Thus, the proposed architecture represents a significant improvement of the original architecture, which provides a new direction for the IIoT development.[5]

In this paper, the author propose a blockchain enabled efficient data collection and secure sharing scheme combining Ethereum blockchain and deep reinforcement learning (DRL) to create a reliable and safe environment. In this scheme, DRL is used to achieve the maximum amount of collected data, and the blockchain technology is used to ensure security and reliability of data sharing. Extensive simulation results demonstrate that the proposed scheme can provide higher security level and stronger resistance to attack than a traditional database based data sharing scheme for different levels/types of attacks.[6]

Data sharing and collaboration via cloud service providers is a stronghold with the increasing advancement of modern technologies driving today's society. In this paper we design a data sharing model between cloud service providers using the blockchain. By implementing the proposed model, cloud service providers will be able to securely achieve data provenance and auditing whilst sharing medical data among other cloud service providers as well as entities such as research and medical institutions without any risk on data privacy.[7]

In this paper, the author demonstrates an approach for handling medical records, providing auditability, interoperability and accessibility via a comprehensive log. Designed for record flexibility and granularity, MedRec enables patient data sharing and incentives for medical researchers to sustain the system. We look forward to formalizing an on boarding procedure for medical research "miners", and exploring mining data economics. In the near future, we intend to carry out user studies to assess the feasibility of the system and to gauge patient and provider interest.[8]

In this paper, the author describes about the Blockchain that offers numerous opportunities for usage in the healthcare sector, e.g. in public health management, user-oriented medical research based on personal patient data as well as drug counterfeiting. The immense potential of this technology shows up wherever, until now, a trusted third party was necessary for the settlement of market services. With Blockchain, direct transactions suddenly become possible, whereby a central actor, who controlled the data, earned commission or even intervened in a censoring fashion, can be eliminated.[9]

In this paper, we introduce an extensible Unique Patient Identifier System that can ensure a unique ID for a patient to go across hospitals anywhere. It is a distributive system and has the advantage in scalability, performance, and simplicity. This enables us to manage the project in phases, and reaping the return-on-investment continually in the entire process. Although this paper provides the technical ground for a complete implementation, a set of comprehensive hospital business processes and policies that supports the management of Unique Patient Identifier must accompany this solution in order to achieve the overall business objective. This includes proper procedures for the medical team and administrative staff to query and identify the patient's identity, as well as the splitting and merging of Unique Patient Identifier by the registration office.[10]

III. PROPOSED METHOD

The blockchain is useful in keeping track of the entire manufacturing chain of the drug. Each new transactions added to a block is immutable and time stamped which means that the information cannot be tampered with. Companies can either have a public or a private blockchain. On these blockchains, the companies can have a distributed ledger shared among the parties involved in the manufacturing and distribution of the drug. Moreover, access is only limited depending on information sharing contract between the two parties. Through blockchain, we are able to get the complete trail of the drug. Each time the drug moves from an entity to another, the information is stored on the blockchain which makes it easy to track the drug and wipe off counterfeits from the shelves. As a result the blockchain technology will help with two main issues: first, it will allow companies to track their products down the supply chain, creating an airtight circuit, impermeable to counterfeit products. Second, it will also allow stakeholders, and especially labs, to take action a posteriori in case of a problem by identifying the exact location of their drugs.

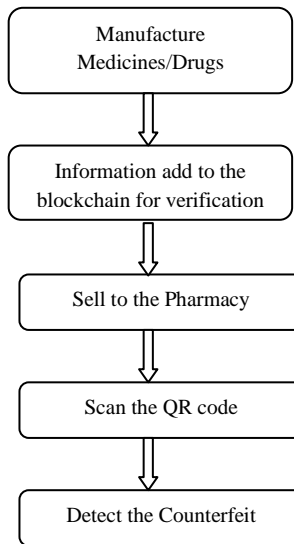


Fig.1 Flow diagram

3.1 Proposed Architecture

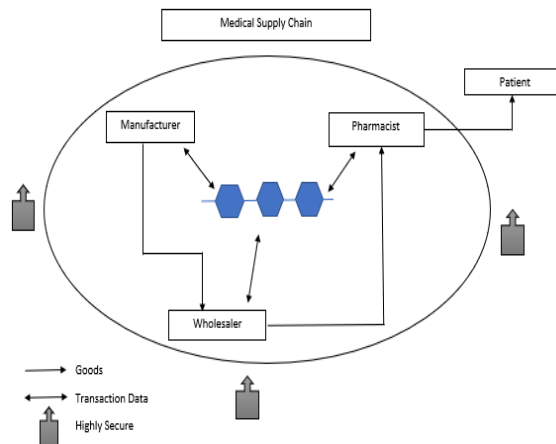


Fig.2 System Architecture

3.2 Module Description- User Interfaces

- Registration();
- Login();
- View Medicines();
- Place Order();
- Transaction()
- Logout();

Manufacturer Interfaces

- Registration();
- Login();
- Manufacture Medicines()
- Generate QR code()
- Transaction()
- Logout();

Wholesaler/Retailer Interface:

Register();
Login();
View Medicines()
Scan code()
Place Order()
Transaction()
Logout();

3.3 Algorithm Details-

Advanced Encryption Standard:

- The more popular and widely adopted symmetric encryption algorithm likely to be encountered nowadays is the Advanced Encryption Standard (AES). It is found at least six times faster than triple DES.
- A replacement for DES was needed as its key size was too small. With increasing computing power, it was considered vulnerable against exhaustive key search attack. Triple DES was designed to overcome this drawback but it was found slow.

The features of AES are as follows –

- Symmetric key symmetric block cipher
- 128-bit data, 128/192/256-bit keys
- Stronger and faster than Triple-DES
- Provide full specification and design details
- Software implementable in C and Java

Operation of AES

- AES is an iterative rather than Feistel cipher. It is based on ‘substitution–permutation network’. It comprises of a series of linked operations, some of which involve replacing inputs by specific outputs (substitutions) and others involve shuffling bits around (permutations).
- Interestingly, AES performs all its computations on bytes rather than bits. Hence, AES treats the 128 bits of a plaintext block as 16 bytes. These 16 bytes are arranged in four columns and four rows for processing as a matrix.
- Unlike DES, the number of rounds in AES is variable and depends on the length of the key. AES uses 10 rounds for 128-bit keys, 12 rounds for 192-bit keys and 14 rounds for 256-bit keys. Each of these rounds uses a different 128-bit round key, which is calculated from the original AES key.

3.4 Mathematical Modeling-

Let us consider S as a system for Traceability of counterfeit medicine supply chain through Block-chain.

S=

INPUT:

Identify the inputs

F= f1, f2, f3 FN— F as set of functions to execute commands.

I= i1, i2, i3—I sets of inputs to the function set

O= o1, o2, o3.—O Set of outputs from the function sets,

S= I, F, O

I = file uploaded by the user

O = Output i.e. fake medicine detection.

F = Functions implemented to get the output

Space Complexity:

The space complexity depends on Presentation and visualization of discovered patterns.

More the storage of data more is the space complexity.

Time Complexity:

Check No. of patterns available in the datasets= n

If (n(1)) then retrieving of information can be time consuming. So the time complexity of this algorithm is O (n^n).

= Failures and Success conditions.

Failures:

1. Huge database can lead to more time consumption to get the information.

2. Hardware failure.
3. Software failure.

Success:

1. Search the required information from available in Datasets.
2. User gets result very fast according to their needs.

IV.RESULT AND DISCUSSION

In this project we are trying to detect the counterfeit medicine supply chain through Blockchain. Experiments are done by a personal computer with a configuration: Intel (R) Core (TM) i5-6700HQ CPU @ 2.60GHz, 16GB memory, Windows 7, MySQL Server 5.1 and Jdk 1.8.

In our system, We compared the proposed and existing system. The overall accuracy of proposed technique is enhanced as compared to existing techniques. So our proposed system accuracy is better than existing system. So this works gives better results as compare to existing method.

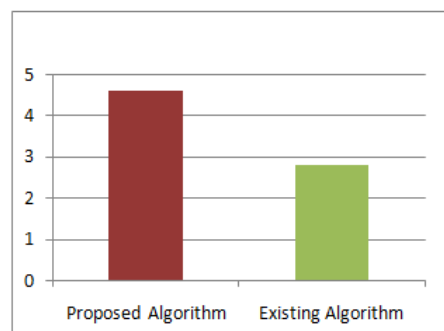


Fig 2. Algorithms Comparison

V.CONCLUSION

The future of fake medicine and the conditions of public health depends on the direction taken by drug manufacture and Government of India jointly. Failing which millions of Indian are going to die. The fake medicine menace can never be combatted with individual drug companies protecting their own brand image and Government trying to underplay the menace. Therefore it is essential to bring drug manufacturers to join hands together with the Government for a cause to benefit Indians (the responsibility of Government) and the consumers of medicines (the responsibility of drug manufactures).There is no other option.Further, develop more new approaches to make it easier for patients to identify legitimate and safe suppliers of medicines.

Develop a robust track and trace mechanism to help the distributors the retail pharmacist and the patient. This mechanism should be easy to implement by all manufacturers.

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