Application of Blockchain Technology In Health Care

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Abstract- *The healthcare system is plagued by the involvement of intermediaries, and there is the severe problem of traceability of transactions that occur. Healthcare data is fragmented across several stakeholders which affects all involved. Clinical trials are not reported, cost of new drug discovery is constantly increasing, and availability of substandard and fake medicines are a huge problem. In recent times Blockchain seems to hold the answer for many problems as the technology involves providing trust between different entities without any intermediating third party. Because of this Blockchain has captured the imagination of the healthcare industry. In this article we will review the usage of Blockchain in healthcare with focus on managing patient data, pharmaceutical research, supply chain management of medical goods, prescription management, billing claims management, analytics, and telemedicine. It was found that most of the block chain projects are limited as white-papers, proof of concepts, and products with a limited user base. This should not act as a deterrent as the quantity, quality, and maturity of these proposed systems are increasing. Discussion on challenges that can occur when adopting block chaining in technical, regulatory, and business challenges in the healthcare industry has also been carried out.*

Keywords- Block chain, Healthcare, Trust, Data Management, Supply Chain.

I. INTRODUCTION

The healthcare industry is one of the world's largest industries, consuming over 10% of gross domestic product(GDP) of the most developed nations[1]. This industry is responsible for provided services to treat the patient. Not only treat it also provides preventive, curative and palliative care to patients. It is a complex interconnected system, where each entity works with strong boundaries for regulating the services. Because the system is highly fragmented it relies heavily on intermediate entities, which results in ever increasing cost. Further more, it lacks transparency hence the patients who are the beneficiaries of this system suffer. These multiple parties lack trust amongst themselves, hence are vary of sharing information. This in turn again affects the patients. Another factor that plagues healthcare industry is the concern by the patients to safeguard their medical records. Patients are always worried about their data being misused by entities of the health care industry. All these above factors have only increased the need for a system that is transparent, secure with no middleman which makes the life of patients who are the chief benefactors of the healthcare system to enjoy its benefit wholly. Blockchain-enabled decentralization promises to minimize the problem of vendor lock-in that has plagued the healthcare industry. Patient data is scattered across different entities in the value chain of the healthcare industry sharing of data is prone to a multi-level process of permission control. Because of this, oftentimes crucial data is not accessible and available at the time of urgent need. Blockchain can solve this issue with health information exchange (HIE) by serving as a basis for a trusted decentralized database. It can enable one-stop access to the entire medical history of a patient across all healthcare providers.

II. BLOCKCHAIN

Blockchains are tamper proof digital ledges that are implemented in a distributed fashion without a central repository and without a third party authority. At a very basic level, they enable a community of users to record transactions in a shared ledger within that community. Under normal circumstance an operation or a transaction once published in a blockchain network cannot be changed. Participant of blockchain use public and private keys to digitally sign and securely transact within the system. At times, users may solve puzzles using cryptographic hash functions to get a rewarded. Blockchain technology was initially implemented in cryptocurrencies however, blockchain technology can be used for a wide range of applications. Without trusted third parties, the trust within a blockchain network is enabled by four key characteristics of blockchain technology:

- **Ledger** – It maintains the full history of transaction and users can only append in the ledger. Transactions once recorded in a ledger cannot be deleted or overridden like in a traditional database.
- **Secure** – Entries in the ledger are cryptographically secured, so that tampering of the data can be prevented also the content in the ledger should be attestable.
- **Shared** – To provide transparency of all the transactions taking place the ledger is shared among the participants of the blockchain

- **Distributed** – Blockchains are inherently distributed to facilitate scaling. When the number of nodes is increased it reduces the chance that a bad actor can impact the consensus protocol.

The structure of blockchain technology is represented as a list of blocks which describe various transactions and are arranged in an order. These lists can be stored as a flat file or in the form of a simple database. The following are the main components of Blockchain architecture:

- Node – User inside a blockchain he has a copy of the ledger.
- Transaction – The smallest building block of a blockchain system.
- Block – A data structure that maintains and stores all the set of transaction facilitated by the nodes.
- Chain – An ordered sequence of blocks.
- Miners – Nodes that perform the block verification process before adding anything to the blockchain structure.
- Consensus Protocol - a set of rules to be followed to carry out any blockchain operations.

III. BLOCKCHAIN IN PHARMACEUTICAL SECTOR

Pharmaceutical supplies are the backbone of healthcare and clinical care. In this section, we will review the various innovative applications and initiatives in the pharmaceutical sector that use blockchain. Areas where blockchain impacts includes drug discovery and clinical trials counterfeit drugs identification and patient adherence to medication.

3.1. Drug discovery and Pharmaceutical research

Significant part of the budget of any pharmaceutical company is taken up by drug discovery. With cost being a factor healthcare companies need to find a way to collaboratively compete in discovering new medical treatments. Blockchain can enable the technological platform to facilitate the transfer of trusted information and knowledge among multiple parties. Blockchain is way through with Intellectual Property(IP) can be safely shared as the records are tamper proofed and time stamped. This paves way for creative collaborations among competitors. Even under a non-collaborative scenario blockchain can be used by Pharma companies to track and manage clinical trials. Major pharma companies outsource their research, under such circumstances blockchain could be used for outcome validation and maintaining the integrity of the data. Blockchain also has use in the management of clinical trials which are also an integral part of pharmaceutical research. IEEE Standard Association organized a forum on Blockchain for Clinical Trial. The Forum's aim was to find ways in which blockchain can be used innovatively in patient recruitment, maintain data integrity, and enabling fast advances in drug development. R. R. Worley. Scry be in their paper - A blockchain ledger for clinical trials, describe a trusted mechanism to expedite the clinical trials and research process. M. B. Ravaud. In his work -Blockchain technology for improving clinical research quality. Trials, 2017shows how blockchain can be used to manage the consent, data, and outcome from a clinical trial in a trustful and open manner. Clinical trials often end up overshooting the budget and time, blockchain tries to solve this problem by enabling different pharma companies to competitively share their research and outcome, thus expediting the research process and also making it cost effective.

3.2.Block Chain for Supply chain and Counterfeit drugs detection

Supply chain is the backbone of the medical industry, its role in provide quality service cannot be overlooked. It starts with acquiring raw material involved in drug manufacturing, storing and distributing them properly. Careful monitoring must be done to ensure fair distribution, optimal usage and ensuring that it is not misused. Of recent years one of the most common problem plaguing the pharmaceutical sector is counterfeit drug manufacturing. There should be some mechanism in place to check and control if the intended end users such as hospitals, local distributers, pharmaceuticals are receiving drugs with correct ingredients that have not been tampered with. There exists quiet a number of loop holes where drugs can be tampered with during the course of transportation between the manufacturer and the retailer. New laws and regulations have been put in place by the government but the concern has not been fully addressed. There must be a robust system in place for tracking and tracing pharmaceutical supplies and blockchain seems to be the ideal solution in sight. Using blockchain information can be stored in an open yet safe manner allowing all the stakeholders to safely access the information. Many solutions have been proposed using blockchain to address this issue. The following table summarizes some of the important work done in this area.

Table 3.1 –Applications of Blockchain in Pharmaceutical Supply Chain Management

Literature	Description
2017,https://www:mediledger:com/. Retrieved from Building an Open Network for the Pharmaceutical Supply Chain:.	Permissioned blockchain solutions to meet the track and trace regulationin pharmaceutical supply chain.
Richard Craib, Geo Bradway, and Xander Dunn. Ambrosus White paper, 2018. https: //ambrosus:com/assets/en/Ambrosus-White-Paper:pdf.	Anti-counterfeit and transparency solution for supply chain with applicationsto pharmaceutical sector among others.
https://modum:io/solution/products,Retrieved from MODSense T1	The solution from this collaboration is intended to improve supply chainsecurity using the One Blockchain platform from the One Network Enterprises.
2018, https://newsroom:accenture:com/news/dhl-and-accenture-unlock-thepower-of-blockchain-in-logistics:htm	Provide distributed ledger technology from blockchain to provide trackingand verification services for pharmaceutical supply chain.
2018, https://www:pmewswire:com/news-releases/ibm-and-hejia-launchblockchain-based-supply-chain-financial-services-platform-for-pharmaceutical-procurement-300437935:html.	The solution from this collaboration is a proof of concept on the use ofblockchain to keep track of pharmaceuticals.

3.3. Blockchain for Prescription Management

Misuse of prescriptions to access and misuse drugs is a very common problem, this takes a serious turn when the drugs involved are opiates. There is already a strong system in place to check the sale of such medicines and drugs, but that does not deter miscreants from abusing valid prescriptions. Also many patients themselves fall into the trap of prescription drug addiction. Many solutions for this problem have been proposed using blockchain. BlockMedx– uses an Ethereum based platform to securely manage prescription processes. All transactions are all securely stored in a blockchain. When a doctor issues a prescription to a patient, the designated pharmacist can verify it through blockchain before issuing the drugs. This system makes the management of controlled drug prescriptions like opioid efficient. Project Heisenberg - P. Heisenberg, 2018 URL https://github:com/tylerdiaz/Heisenberg.Solving prescription/pharmaceutical logistics using smart contracts is uses smart contracts on top of Ethereum to track prescriptions. It provides separate portals for patients, doctors, and pharmacies for their stake into the prescription process. Script Dropuses blockchain in streamlining pharmacy delivery to patients. Drugs are directly delivered to patients without them having to visit the Pharmacy and also they use a virtual assistant to check if patients are adhering to the prescribed medicines. Scala Med offers patient centric services like medical adherence, tracking all prescriptions using blockchain.

3.4. Blockchain for Claims Management

In the healthcare industry financial aspect plays an important role and it is also highly inefficient when it comes to transparency and trustworthiness. This issue can be easily addressed with the help of blockchain. Blockchain can be used to create a direct link between the patients who raise the claim and the bearers usually health insurance companies that pay out the claims. This creates a trusted link between the two participating entities. Smart Contracts can be used during negotiation of premium payment. Information regarding the current health status, medication usage, lifestyle can be connected to premiums, through smart contracts. During the process of handling claims usually a lot of repetitive tasks like verifying the documents is done. Looking into all the above said issues few initiatives have been developed using block chain to address them. URL https://enterprise:gem:co/health/. Retrieved from Gem – Health uses Ethereum to streamline claim management. It provides insights into a patients health journey by brings the patients, providers, and the insurers together into one system and eases the job of health claims management. Change healthcare is using the Hyper Ledger Fabric framework for blockchain based claims and revenue management. HSB lox has unveiled its RevBlox(TM) and CuraBlox(TM) product for claims management built on top of their blockchain platform dubbed SETU (Simplified Exchange and Transparency for Users). Many large healthcare companies, including insurers like Humana and United Healthcare, have been working on a pilot program using blockchain to maintain and share curated information from healthcare providers. This feature can solve a lot of redundancies and inefficiencies related to insurance claims management.

IV. BLOCK CHAIN AS A SERVICE (BAAS)

Several organizations are developing solutions and services using blockchain that can be used by the healthcare industry. Pokidok is providing a service to healthcare provides with which they can integrate their current system with blockchain system. Services provided by the new system includes access, benefits and claims management. Hashed Health provides healthcare enterprises the required support to create new blockchain based solutions and integrate with existing

systems. Factomis an enterprise-focused blockchain company that offers solutions such as Harmony Connect and Harmony Integrate. IBM has introduced IBM Blockchain Platform on top of Hyper ledger Fabric which allows users to create their own blockchain solutions. Guard time provides blockchain based solutions through its KSI technology stack .Instant Access Medical and Healthcare Gateway, launched a blockchain-supported personal care record platform called MyPCR . SSOT Health is developing a platform to create healthcare blockchains based in Hyper ledger.

V. CHALLENGES

All though Blockchain seems to be the one stop solution for major issues plaguing the healthcare industry, there are some key issues that must be addressed when migrating to Blockchain. The transition is not going to be very smooth as we would imagine. In this section, we will discuss some of the challenges faced by blockchain.

- Interoperability & integration with the legacy systems - Blockchain system must integrate well with the existing systems. Interoperability is of high value as healthcare systems involve lots of participants in terms of devices, technology as well as personals involved.
- Adoption and incentives for participation – For blockchain to succeed in healthcare the participating entities must be willing to change their business model. To motivate the participants incentives can be offered to stakeholders to make the system a success and ensure active participation.
- Uncertain cost of operation – Since blockchain does not have any centralized authority, the cost of operation of a blockchain enable health care system is unknown and cannot be calculated.
- Regulation – Strong rules are put in place to ensure the safety and security of patient information. One of the challenges would be to see how it works with all the existing regulations.
- Governance – Blockchain follows a decentralized approach, but in the health care industry certain participants might want to take the role of leads. This model of operation is entirely different from the way in which blockchain works and may cause issues.

Apart for the issues addressed earlier the following issues might also have to be addressed

- Technical Sufficiency
- Legal Issues
- Business Models and Rules
- Trust issues

VI. CONCLUSION

In this paper we have discussed the basis working of the blockchain technology and how it can be leveraged to solve crucial issues faced by the health care industry. We have also discussed some of the existing blockchain based health care solution provided by key players and the quality of service provided by them. Despite the amount of literature available, and the hype surrounding the possibilities with blockchain, till date health care Industry has not embraced blockchain completely. It is in a very nascent state, however given some time blockchain has the potential to hugely impact the way in which the health care industry works.

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