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Applications of Blockchain in Healthcare

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Abstract
Numerous problems in healthcare originated from the complex network of intermediaries and the lack of traceability of transactions.To mention a few: healthcare data is segregated across several archive negatively affecting research and services, about half of the clinical trials are never reported, the cost of drug discovery is ever increasing, and low grade and fake medicines are still a huge problem.Blockchain has the potential to untie these problems as it provides trust without any intermediaries, has traceability as a default feature, and promises new business models by enabling novel incentive structures.Due to its capability, Blockchain has gathered significant interest in the healthcare industry.
In this paper, we have reviewed major use cases of Blockchain in healthcare: like Blood Bank,pharmaceutical research, supply chain management of medical goods, patient data management, prescription management, claims management, analytics, and telemedicine alongside the related projects.
Keywords: *Blockchain,BloodBank, healthcare*

I. INTRODUCTION

The healthcare sector is one of the world's largest industries, consuming over 10% of gross domestic product of the most developed nations. Simply put, this industry includes generalization and commercialization of goods and services to treat the infirm with curative, precautionary, rehabilitative, and palliative care. Being a complex system of reciprocally connected entities under heavy regulatory boundaries, patient data is highly shattered and the cost of healthcare delivery is continuously rising due to counterproductive in the system and dependence on several intermediaries. Furthermore, pellucidity on the whole process of enabling data sharing between multiple parties, even though supposedly beneficial to the patient, is still lacking on full transparency and control from the patient's view. Patients have shown concern about the possibility of their data being used by for profit entities This has accentuated a need for an information technology(IT) system that can remove the middlemen or suspected element and rectfies costs while maintaining trust and transparency. The Blockchain is a revolutionary technology which can assist in solving the challenges of healthcare by providing decentralized trust. Blockchain enabled fragmentation of promises to minimize the problem of vendor lock-in that has plagued the healthcare industry.

1.1 How secure is it.

In today's digital world, distributed systems interact with each other for data and information exchange. We want each interaction between the systems to be secure and reliable. Blockchain is a new technology that promises an efficient, cost-effective, reliable, and secure system for transferring and recording any transaction without the need of middleman which leads to most effective secure process.

Trust and traceability are the two basic promises of the blockchain obtained out of the box which solves the generic trust problem on all public, federated, and organization levels. However, these traits are not always sufficient to provide a complete solution, which is why we often see blockchain paired with strong cryptographic protocols like zero-knowledge proofs. This pairing ensures to provide trust, traceability, security, and control which are the core building blocks for critical solutions in several industries including health care and supply chain. Data recorded in the blockchain cannot be changed or deleted without leaving a trace. This immutability and traceability of the data is a critical requirement for any health care system. Thus, the benefits of blockchain seem imminent.

Here, I list some of the core issues/concerns that need to be addressed in health care solutions and later show how blockchain could help in solving them.

• Secure storage and integrity protection
• Privacy and ownership of data
• Data sharing
• Traceability and accountability of data

While each of these concerns can be addressed separately with the proper use of cryptography and privacy-preserving technologies, the key concerns in such solutions have always been the governing trust model. In such solutions, blockchain as a trustful decentralized ledger technology can act as a trust binding glue.

1.2 Blockchain in Healthcare.

Blockchain with its segregated ledger technology has captured the market's attention for its data handling capabilities with respect to decentralization and security. With its relatively successful implementation in the financial domain, various industries are now realizing its benefits and are exploring the potential of blockchain in their respective domains. Healthcare is one such industry looking at unlocking the benefits of blockchain. Several opportunities exist in healthcare wherein blockchain can help improve interoperability and privacy of patient health data. Some of the important healthcare applications are discussed in this article.

1.3 Blockchain for Health Records

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1.4 Blockchain in Clinical Research

While there has been a considerable advancement in moving medical data from paper to digital records, healthcare industry is still working its way through issues regarding sharing of patient data across providers and organizations. Throughout their lives, patients may move cities, change health plans, switch their healthcare providers for their treatments. Most of their detailed medical records tend to remain in silo with the individual facility or provider. Furthermore, each medical entity would have saved patient data in their own storage structure and semantics. This leads to hurdles when it comes to sharing of the data. 5 These hurdles are partly due to nature of the data in question (Protected Health Information) or to prevent information blocking during exchange. This not only has an implication on treating patients efficiently across multiple organizations, but also hampers the field of clinical research, which requires real life medical data to conduct research and test their hypothesis in real world scenarios with real world data. Clinical trials need patient data which is de-identified. Consolidating and de-identifying patient data takes significant time and effort, which leads to a considerable cost. A critical factor in attaining higher accuracy in outputs of clinical research and trials is the availability of large sets of real life de-identified raw data, analyzable datasets for secondary analysis and meta-analysis Polls show that majority of consumers are open to sharing their medical records for analysis and research on the assurance that their privacy is maintained, and the data is secured.

1.5 Application and Implementation of Blockchain in HealthCare

With trust is built into Blockchain database, there is a high degree of transparency. Records are publicly writable by anyone and owned (stored) by no one, with security of data being provided through encryption. Using private and public key cryptography, a shared ledger can facilitate information sharing and community driven clinical study. Patients can directly control their medical data and rights to grant or withdraw data access to care givers and organizations. Such a platform would be a vital in helping research organizations get direct and secure access to a vast repository of holistic and accurate clinical data.

1.6 Blood Chain-Tracking Blood Journey through Blockchain

The current problems with blood donation tracking, especially in the third world, is that there is no homogenous, inexpensive, and transparent way to track blood. Using blockchain technology, we allow anyone to track a recipient from a blood donor where a specific blood has been donated, the donor's compliance information and if / where it has been tested. But our startup does not stop there, it also opens up general medical information like shot records hosted on the blockchain. This is different from our environment which is essentially blockchain hosted medical information which is then mined and analyzed through distributed AI. The end result allows researchers to predict near-accurate effects of certain diseases, allows the government to verify compliance in medicine such as blood donation, and allows diagnoses such as IBM Watson.

1.7 PLASMA DERIVATIVES BLOCKCHAIN

In this section, we will discuss some use cases for blockchain in plasma supply chain. We intend not to outline a finalized specification but rather raise ideas for further research and prototyping. It is straightforward to infer that blockchain can be utilized across the plasma supply chain in a similar way it is used with pharmaceutical supply chain. Two self-evident use cases are those relating to preventing the falsification of plasma products and the logistics of plasma.

First, blockchain could be utilized in the same way MediLedger is used to counter falsified medicines. The main components here would be a private blockchain, hosted by plasma supply chain actors, and nodes representing supply chain actors. A plasma delivery would be assigned an identity, stored in blockchain along with the certificate of origin. When the delivery progresses in the supply chain, each step is recorded in the blockchain complemented with other relevant information. Supply chain parties can access the blockchain through their nodes and enquire the origin of the delivery and individual donations, while maintaining a high level of privacy.

Blockchain's main role here would be to verify logistics transactions and provide immutable ledger, which prevents attempts to tamper any origin information or inject falsified plasma to the supply chain. The benefits would also include the enhanced traceability of plasma: for example, in the case a delivery has to be withdrawn due to a contaminated donation, it would be easy to follow the blockchain trail from the single donation to the batch and its current location.

Second, as plasma logistics is a major transatlantic industry, whereby the product is highly sensitive in terms of storing conditions, a solution monitoring these conditions, and raising alerts where applicable, is another area blockchain could be utilized in. The benefits would include that blockchain would verify plasma batch's shipping conditions and provide information if there are any suboptimal conditions across the shipping chain that may cause defects in the plasma. Again, this solution would be based on a private blockchain, which is accessed by nodes representing the supply chain parties. Logistics transactions would be stored in the blockchain and the solution would incorporate IoT sensors monitoring the batch.

In addition to these two use cases, we introduce a third one, which is based on the donor's perspective. The idea here is to provide mechanisms for incentivizing donors and allowing them to take better control of their data and donations. From a governance point of view, this would also allow monitoring individual donations and prevent too frequent donations. Generally, this would entail a distributed, decentralized donor registry, whereby a donor's data, such as health screening, would be located in one authorized donation center and donation events would be recorded in the blockchain. Each of the donors would have a single identity, which would work in each of the centers.

From an ethics perspective, the end customer of plasma could monitor donations and exercise corporate responsibility: for example, it could be monitored that a donor does not donate too frequently (e.g., by going to different centers). The health effects of too frequent donations are not clear, but there may be an adverse effect. The controlling could be conducted with a smart contract. For example, if a donor's previous donation is within a certain time period, a new donation is forbidden.

Another key factor in this model is an incentive model, which could be tied to the system. For example, rather than remunerating with cash, donors could be granted tokens they could use in public health services, public transportation or other public services. This would follow the example of BLOOD tokens described above. In a more far-reaching manner, blockchain could contribute to a diminishing role of the middleman (i.e., the global plasma collection firms, which currently collect plasma and remunerate donors). A completely new

kind of plasma supply chain networks could be built whereby donors could obtain an increased control to their donations economically.

, which illustrates how donors donate the plasma across the network of trusted collection centers. The donor is registered in one of the collection centers and identified through blockchain. The donation transaction is verified with blockchain and recorded with the user's data in a secure data source.

1.8 Challenges in Implementing Blockchain Technology

In the last decade, blockchain technology has been widely adopted in the banking industry. However, there is not yet awareness and familiarity with this technology in the healthcare domain. Organizations face challenges in understanding how blockchain works and the benefits associated with it. Enterprise systems are still centralized, and organizations are not ready to adopt an entirely new distributed data culture by implementing blockchain. Another challenge facing companies in implementing blockchain is around investment. The cost of executing peer-to-peer transactions on a blockchain network is huge to ensure speed and effectiveness. While blockchain technology has its own set of challenges, it can play an important role in addressing the current interoperability and security challenges of the healthcare industry. The seven challenges in implementing Blockchain technology are scalability, Transaction Speed, Decentralization, Talent shortage, Ecosystem, Energy, Resilience & lack of standards[4]. The first challenge is the technical scalability of blockchain, which is, at least for public blockchains, a hurdle that could limit their adoption. Scalability is less of a problem for private blockchains, such as Hyperledger, since the nodes in the network have a direct interest in processing transactions. new distributed ledger technologies are being developed that offer thousands or even millions of transactions each second. However, the deployment of these new distributed ledger technologies in enterprise environments is still limited. decentralisation is tackled differently when it comes to private blockchains. it does not matter if only a dozen nodes control the network. There are already hundreds of blockchain start-ups, all trying to attract the same limited talent, yet organisations are faced with a talent pool that is expanding more slowly than demand is growing. It is estimated that the PoW consensus mechanism in the bitcoin blockchain currently consumes 66.7 terawatt-hours per year, which is comparable to the total energy consumption of the Czech Republic, a country of 10.6 million people. There are also challenges related to data on a blockchain. Resilience and irreversibility are two key attributes of blockchains; once data or transactions are appended and accepted by a network, they can no longer be changed. However, only authenticity can be ensured through a blockchain, not reliability and accuracy. the decentralised ecosystem consists of multiple layers, which many of these layers are still under development:

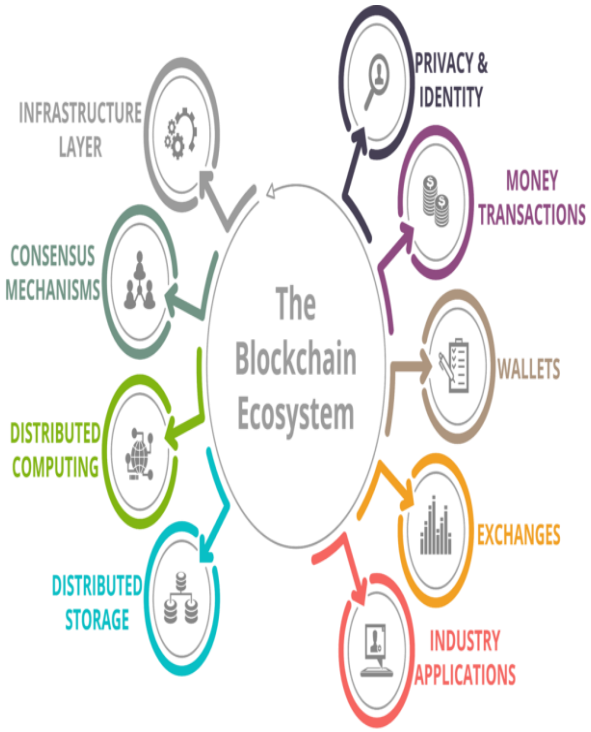

Figure 1 Decentralized Eco System

Source : https://medium.com

II. CONCLUSION

Blockchain technology is an emerging technology and has a huge potential not just to impact few industries but it can change the way businesses are done. The adoption of blockchain technology in healthcare has started and we can expect to have commercial blockchain solutions in the market in near future. Most of the healthcare use cases for blockchain are intended to provide secure and integrated care to the patients.

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