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Literature Review

BLOCKCHAIN: The Upcoming Technology and Applications

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Introduction

Over the years, healthcare needs have slowly exceeded available medical resources as populations have aged and healthcare delivery has become more complex and expensive. Block chain therefore is becoming one of the most promising technologies grabbing the interest of both business and several academic researchers. The rapid growth in blockchain usage is due to its advanced features like immutability, transparency, distribution, accountability, security, and reliability. Furthermore, it improves the integration of other disruptive technologies such as machine learning, artificial intelligence and others.

Blockchain is a peer-to-peer, decentralized, distributed, tamper-proof, digital ledger used to safely store transactions on many computers within a P2P network, without the requirement for a central third party. The concept initially came into light from a white-paper written by Satoshi Nakamoto, a mysterious person or group who designed Bit coin. The incentive behind Bit coins is, consequently, to overcome the limitations associated centralized systems.

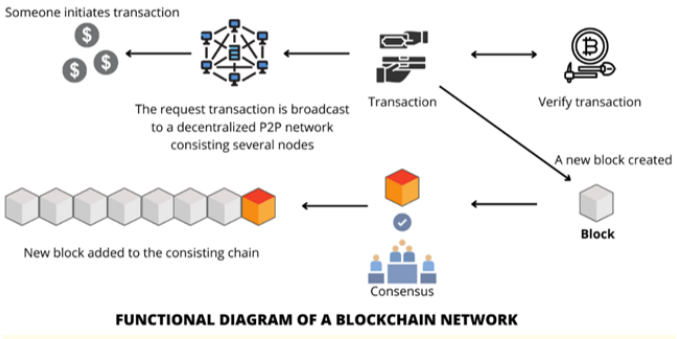

Figure 1

Evolution of blockchain

Blockchain 1.0, the first iteration of the blockchain technology, built on Bit coin. Block chain 2.0 introduced the concept of a "smart contract," which is recognized as a piece of code that has been designed, executed, and recorded in the distributed ledger, has evolved in the second generation.

Blockchain 3.0, the third generation of blockchain technology, focuses mostly on non-financial applications including those in government, energy, healthcare, and more. In reality, a number of organizations have embraced this technology and used it for a variety of healthcare-related use cases. The most interesting features of blockchain that benefit healthcare applications are decentralization, privacy, and security as blockchain technology can ensure secure access to medical data for patients, various individuals and stakeholders (health care companies, hospitals, doctors, etc.).

Blockchain 4.0 aims to make the technology widely used by providing a business-friendly environment for developing and running apps. Previous incarnations of blockchain technology have demonstrated clear potential benefits for organisations, including security, automatic record-keeping, immutability, and the ability to pay bills, salaries, and invoices in a completely secure environment.

Blockchain glossary

Recording transactions over time while allowing tracking and analysis. This is a way to document the transfer of ownership and ultimately prove ownership, known as the ledger.

A block is a unit of data (or record) that contains a collection of transactions that form a blockchain with many other blocks arranged in a particular order. The Hash is a digital version of the fingerprint. It is unique and helps detect changes in the file. This is the component that secures the blockchain. Consensus is the

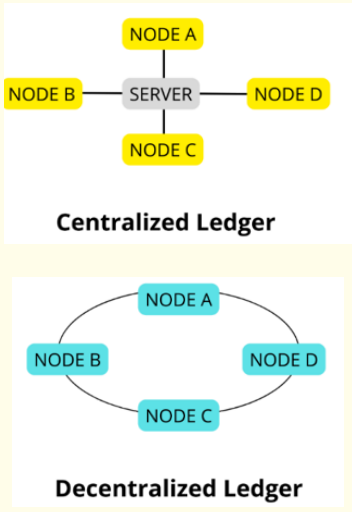

Figure 2

process by which a group (or node) of peers on your network determines which transactions in that particular blockchain are valid and which are invalid. The consensus mechanism is the method used to attain this endorsement. It is set of policies or rules that assist guard your community from malevolent conduct and hacking attacks. Proof of work is one of the most popular consensus mechanisms. Blockchain users/nodes compete with others to solve complex cryptographic problems, validate a specific block, add that block to the blockchain, and get rewarded for it is known as miner. Smart contracts are simply programs stored on a blockchain that run when predefined conditions are satisfied. They are often used to automate the execution of an agreement so that all participants can be immediately sure of the outcome without the need for middleman intervention or loss of time. They are self-executable and self-verifiable. They can also automate workflows, triggering further action when conditions are met.

Distinction of Block chains

- **Public block chains:** Anyone can access these block chains since it has no restrictions which makes it open to public.
- **Private block chains**: Blockchain that is not open to anyone join and requires special permissions to join.
- **Consortium block chains:** Consortium block chains are licensed semi-decentralized block chains that are managed by a group of organizations, rather than one entity. Multiple organizations can act as a node and exchange information or perform mining.
- **Hybrid block chains:** Private and public block chains combines to form hybrid block chains. Some part of the blockchain is supervised by some organization while other part is made visible or open for everyone as public blockchain.

Application areas

Healthcare

One of the areas where blockchain is seen as having great potential is healthcare. Healthcare issues such as data protection, quality of care, information security, etc. have received worldwide attention in recent years. the main benefits of leveraging blockchain technology for healthcare data management system are health data accuracy, health data interoperability, health data security, health data handling costs, global health data sharing, improved health care data audit. Other areas of health care including proof of service, medical billing, clinical trials, medical record exchange, contracts, and anti-counterfeiting drug can benefit from blockchain technology.

Keeping in mind that the purpose of this review is to identify use cases and examples of blockchain-based health care applications along with to understand the limitations and challenges of blockchain-based health care applications present today.

Banking/Finance

Since the existing banking system is dependent on a central authority and moving funds or making payments requires direct or indirect to these institutions such as credit card companies, these adds to layer of complexities along with increased costs. With blockchain technology, however these can be minimized since blockchain can streamline the transfer process. Traditional payments options like Cash, wire transfer and cheques are untraceable, time consuming and cheques can be forged, blockchain solves all these issues with greater confidence. The smart contracts used in certain block chains helps in automation of time-taking and complex transactions and they can reduce the human error rate and it work 24/7.

Crypto currencies or Digital Currencies using blockchain as their underlying technology can prove to be an alternative to traditional fiat currencies which can in near future help in transferring money to other countries without excess costs,

Supply chain management

Traditional supply chain lacks availability of trustworthy information and openness. Blockchain which is immutable and uses

open permissioned ledgers helps to make an environment where the information is trustworthy and the risk of false information and tampering of data is minimal. One of the main problems that blockchain can tackle in SCM is synchronisation of trustworthy data/information as it enables a single source of truth available to all players in the system. Several sectors that can benefit from this integration of Blockchain in Supply Chain management are – Manufacturing Sector.

Literature Review

Attaran, M. [1] sheds light on some of the challenges faced by patients and healthcare practitioners in terms of accessing, managing, integrating and sharing healthcare records. The author proposes that the patients should be the in charge of their own medical records and should be able to manage their own health records and should be able to give required authorization to the medical institutions. Attaran also points out that the current infrastructure has proven to be inadequate in times such as COVID-19. Another issue raised by author is that of interoperability and that of privacy of the data. During their research the author(s) found out that the integration of blockchain is in its integration with the current healthcare system is in its initial stages and that it requires more working to be done, also for blockchain to work, "it requires redefining relations of all involved players from healthcare providers to patients and the pharmaceutical industry".

Leila Ismail, Huned Materwala, Sherali Zeadally [6] proposed a lightweight blockchain architecture to reduce the overheads compared to bitcoin by dividing the network participants into groups and maintaining a single copy of ledger per group, this was so done by replacing the energy consuming mining consensus protocol of the Bitcoin network with a scalable and an energy-efficient consensus protocol. They also proposed a solution to avoid forking which prevails in the bitcoin network by using a head blockchain manager. Analysis was done to check the effectiveness of proposed architecture in providing security and privacy by examine different threat models which exists in Bitcoin Model. They also ran a simulation to evaluate and compare their models' performance with the bitcoin network.

Gan, Chenquan and Saini, Akanksha and Qingyi, Zhu and Xiang, Yong and Zhang, Zufan. (2021) proposes that patients should be given a key administrative role to be played to give authorization to medical institute to legally use their medical data and proposes a blockchain based access control scheme and an incentive mechanism is used to encourage patient to actively share their data. Though recent changes of original paper based medical records (PMRs) to electronic medical records have proven to be convenient and beneficial to medical institutions but it is not conductive to data sharing and interacting with other medical institutions. Difference in software and hardware of different medical institutions results in incomparability between data sharing and access to these records require prior authorization which increases time cost. They propose a model where Medical Institutions will be responsible for processing and storing of data into the blockchain.

Claude Pirtle and Jesse Ehrenfeld proposed that blockchain can be used in creating a system for monitoring a pharmaceutical supply chain, medication management, setting up a permissioned block chain which reports the population health data directly to CMS, creating a de-identified research dataset.

Emmanual Boateng Sifah, Kwame Omono Asamoah, Jianbin GAO3, Xiaojiang Du, (Senior Member, IEEE), And Mohsen Guizani discussed how inefficient ways of handling patient's record can result in diverse risk which can harm a patient's privacy. Authors propose MeDShare, a system that addresses the issue of medical data sharing among medical big data custodians in a trust-less environment.

Anton Hasselgren, Katina Kralevska, Danilo Gloigoroski, Sindre A. Pedersen, Arild Fazxvaag, in their research stated that due to over-arching importance of maintaining trust while being able to exchange data within the healthcare ecosystem, medical institutions are critical demand for trust-preserving solutions. They also shed light on areas such as Knowledge infrastructures, Picture archiving and communications systems, Automated diagnostic service for patients, Administrative systems, Population health management system and Pharma supply-chain that needs to be taken into research.

Shyun Shi, Debiao He, Li Li, Neeraj Kumar, Muhammad Khurram Khan, Kin-Kwang, Raymond Choo through their research tried to dive into the security and privacy aspects of the various existing Electronic Health Care (EHR) models designed. The potential of EHR models was evidenced during the novel coronavirus where remote patient monitoring and other healthcare deliveries were increasingly used in order to contain the situation.One of the issues raised in this article was that of the Centralised server model of existing HER models which may be a concern as of single point of failure, this very concern can be mitigated by blockchain. as it is a decentralised server model. Since data is recorded in the public ledger, and all of nodes in the blockchain network have ledger backups and can access these data anytime and anywhere, such a

system ensures data transparency and helps to build trust among distributed nodes. By leveraging the interconnectivity between different healthcare entities, shared data can improve medical service delivery.

Hölbl, M.; Kompara, M.; Kamišalić, A.; Nemec Zlatolas, L. through their research work gives us the various potential blockchain technology has in healthcare if used efficiently with correct infrastructure. The research was done by analysing 33 publications which were further analysed with predefined criteria and research questions. Their key findings were that the usage of blockchain in the healthcare has increased but only for purpose of access control and systematic record keeping but was rarely used for other scenarios such as supply chain management or drug prescription management which indicated that this technology is not used up to its potential. They also suggested that smart contract could be used as they can automate processes within a blockchain platform [1-9].

Conclusion

The usage of blockchain, though in infancy stage has a bright and disruptive future that can benefit every sector with some application and can tackle trust and information related problems. The only hindrance in the adaptation of this technology is the lack of awareness and the costs related to building the infrastructure required to run the application. Overcoming these obstacles might help in mass adoption and it can help in building trusts, automation of various tasks and reduced costs.

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