A Comparative Analysis Between Hyperledger Fabric and Ethereum in Medical Sector: A Systematic Review

K. B. Jyothilakshmi, Vandana Robins, and A. S. Mahesh

Abstract In a medical record management system, a complete database is used to store and obtain patient medical information. The electronic medical record has supplanted the conventional paper medical record as the primary source of healthcare information for clinical, legal, and administrative purposes. The risks of data being misused are high because the patient has no control over the data. As a consequence, we need a patient-centred approach that is fully decentralized, capable of detecting data theft, preventing data abuse, and enabling patients to exercise control over their access. The perfect approach to all issues and needs is Blockchain technology. Blockchain has the potential to have an effect on billing, record sharing, medical testing, identity theft, and financial data theft in the future. In addition, the implementation of smart contracts in healthcare could make things much simpler. When this command is used, the Blockchain can be used to create and validate records. This paper compares and contrasts the most widely used Blockchain systems. The Hyperledger framework and the Ethereum platform are the two major general-purpose blockchain frameworks in use. The primary difference between Hyperledger and Ethereum is the purpose for which they were developed. The primary goal of this paper is to find the contrast between these two blockchain platforms for medical record management systems in order to determine which blockchain platform is best for developing healthcare applications.

Keywords Blockchain · Hyperledger Fabric · Ethereum · Smart contract · Healthcare application · Consensus · Permissioned · Permissionless · Distributed ledger · Hash

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1 Introduction

In recent years, health information management networks have faced a number of problems; the most significant of which is the management of patient record data. With the abundance of wearable medical records outside of medical facilities, modern medical practices rely heavily on patient's historical medical records, which are becoming increasingly huge. Since medical records data is so important to a patient's diagnosis and care plan, it is critical to ensure that the data's credibility is protected. Health data can be kept secure, private, and inter-operable using blockchain technology. The Hyperledger Fabric framework and the Ethereum framework are two common trendy-purpose frameworks. This paper contrasts the medical record management system's general-purpose mechanisms. Hyperledger Fabric is a plug-and-play blockchain platform that can be used to create blockchain-based products, solutions, and applications for private businesses. Ethereum is an open-source and distributed decentralized blockchain network. With the support of smart contract functionality, it allows for the development of decentralized applications. The most important difference between Hyperledger Fabric and Ethereum is the reason for which they were produced. The most significant aspect of Ethereum is that it allows smart contracts to be executed, enabling decentralized applications to be created on top of all. It was the primary blockchain-based network to implement the idea of smart contracts, which is why it is so popular for developing decentralize applications based on smart contracts, such as healthcare apps. The Ethereum platform has a few drawbacks when it comes to creating healthcare software. It faces some of the flaws as Bitcoin: miners must be compensated in ether, a cryptocurrency that is immune to a 51 percent assault. Hyperledger Fabric, in contrast to other systems, is one of the most comprehensive solutions for designing healthcare applications. Hyperledger Fabric has security features and robust privacy. As a result, the developers have a robust toolkit at their disposal for rapidly enforcing a wide range of privacy and security policies. Unlike the other frameworks, Fabric supports smart contracts and does not rely on a computationally intensive consensus protocol, Fabric does not accept cryptocurrency as a payment method. The purpose of this work is to compare and contrast these frameworks in terms of medical data management system requirements in order to decide which framework is more effective and stable.

We followed the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-analyses) guidelines when performing and reporting this systematic literature review. Our aim is to find the best blockchain framework for a record management system, so we choose this type of literature review. Also, to summarize the benefits, drawbacks, and potential directions of each blockchain platform in the healthcare sector. Unlike a meta-analysis, this study did not provide any data synthesis. There was no quality assessment since the aim was to establish a shared interpretation of the actions and solutions instead of to evaluate the performance of various blockchain platforms.

The following activities were described as part of our review.

1. Research Questions.

2. Search Strategy.
3. Article selection.

2 Related Works

(1) Comparison of blockchain platforms: a systematic review and healthcare examples
Tsung-Ting Kuo, Hugo Zavaleta Rojas, Lucila Ohno-Machado

They identified healthcare blockchain applications as well as platforms that have been proposed or implemented by state-of-the-art healthcare blockchain studies in this study. The authors conducted a systematic evaluation of 21 parameters for ten common blockchain platforms in order to assist health informatics researchers in selecting the best appropriate platform for their unique application. They explored essential blockchain implementation elements, introduced these platforms, and compared the most significant technological elements to healthcare in their study. Their findings demonstrate that while most platforms have comparable functionalities, they differ in technological qualities like as transaction speed, block mining centralization mitigation, user privacy or anonymity enhancement, and support for permissioned or private blockchain networks. Based on their findings, which show that most healthcare or biomedical lead projects are still in the conceptual stages, they predict that implementing blockchain technology in the healthcare or medicine domains will necessitate a societal revolution that will be far more difficult than the technological difficulty. Vision, entrepreneurship, and a little initial investment that will likely pay off in a few years will be required to think differently and change the way our sector functions for decades. The intrinsic benefits of blockchain (decentralization and immutability of the ledger) need scenarios in which a minimum number of users choose to utilize it, with some agreeing to actively contribute "blocks" and perform other activities (for example, predictive modelling) for healthcare or biological applications. If the correct incentive system can be put in place, the transition will undoubtedly occur.

(2) Comparison of Smart Contract Blockchains for Healthcare Applications
Hongru Yu, Haiyang Sun, Danyi Wu, Tsung-Ting Kuo

They addressed practical considerations while developing a hospital blockchain and smart contract system in their study. They examined the technical aspects of smart contract blockchain platforms, chose platforms for their research, built a blockchain network for each platform, tested the blockchains, and summarized their experience, and time spent implementing them. MultiChain is the simplest blockchain platform to set up, according to its implementations. Ethereum took longer to start up as a permissioned network than MultiChain. Hyperledger Fabric's network has more layers to boost manageability and security, but it can take longer to set up than other platforms. In comparison to Hyperledger Fabric, installing the software required for MultiChain and Ethereum is also simple. On the other side, Ethereum and Hyperledger offer full smart contract functionality, whereas MultiChain's smart contract support is limited. The smart contracts are simply programmable and extremely readable.

The following are the key differences between the three platforms when it comes to biomedical/healthcare applications. A big community of developers from all over the world supports and maintains Ethereum. It is a smart choice when contemplating the long-term viability of the platform on which the applications are built because of its open nature. The blockchain platform's versatility, security, and manageability are enhanced by Hyperledger Fabric's well-designed, multi-layered access control system and Hyperledger Fabric's own certifications. MultiChain is intended to be a permissioned blockchain that is both simple and powerful to use, and it forks from the well-known Bitcoin Blockchain to inherit established features.

3 Blockchain

A shared (or distributed) database is what a blockchain is. It is a complex framework for packaging data in a way that you can trust, and it can only be changed by specific users. Once data is generated, it is broadcast and validated on a peer-to-peer network before being compiled into a block of information. The block is mixed with several information (a hash key) from the preceding block using a cryptographic method called as hashing before being added. Since it combines the previous block's Hash key, each new block is connected to all of its predecessors in the form of a chain. The block's transactions are organized into a Merkle tree, with each transaction verifiable to the centre.

Another important feature of blockchain is persistence. It is almost difficult to erase data when it has been admitted into the blockchain based on distributed ledger, which is held across several branches. It can only be accessed and changed by those who have the correct key. Each time the data is modified, a fresh information block is validated and posted to the ledger. Permissioned participants and validation tools work together to validate or deny new data if anyone attempts to tamper with a transaction or block in the chain. This procedure ensures that blockchain is a safe, stable, and reliable source (Fig. 1).

3.1 Types of Blockchain

Blockchains can be divided into three categories.

1. public (permissionless),
2. consortium (public permissioned),
3. private.

They vary in terms of who has access to, writes to, and reads the details on blockchain.

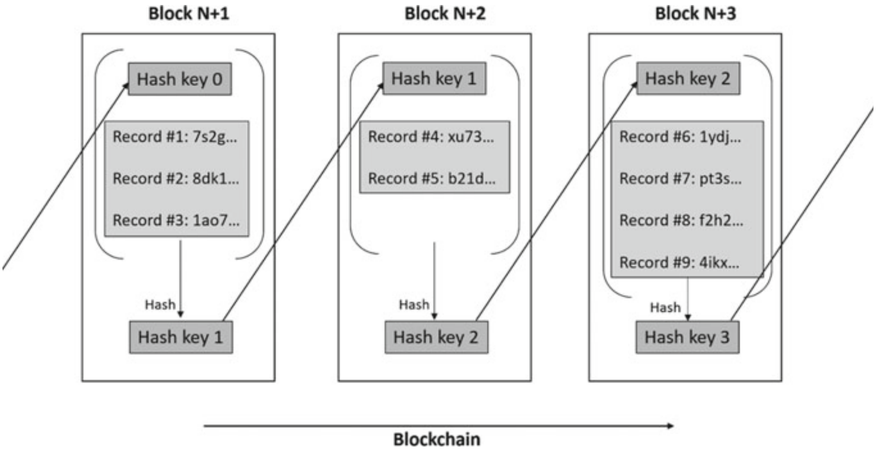

Fig. 1 Data blocks in a blockchain are connected together

Public

Everyone can access the data in a shared chain, and anyone can enter, contribute, and modify the core software. The public blockchain is commonly used in cryptocurrencies, such as Bitcoin and Ethereum, which are both public permissionless blockchains. Anyone can view, perform transactions, and participate in the consensus process on a public blockchain. It is totally distributed, decentralized, and transparent, which means that whatever transactions take place in the public blockchain network can be seen by anybody with basic internet connection. There is no middleman on the public blockchain, which means that there is no control over the network's operations.

Consortium

A consortium blockchain is partially centralized since only a limited number of relevant categories of organisations have rights to display and interact in the consensus protocol. This sort of blockchain is a variation of private blockchain. It tries to take away the private blockchain's sole autonomy which means that the network is managed by more than one individual or corporation. Blockchain consortium is a form of hybrid between public and private blockchains since, although being a permissioned network, it has a decentralized structure. Each organization in this network receives the same treatment, ensuring that all parties engaged are treated fairly. The network is not ruled by a single body. It is a platform that allows numerous firms to collaborate and share data while also keeping track of rules and records.

Private/permissioned

The network in a private blockchain is distributed but also centralized. Only a few nodes are allowed to join the network, and they are all regulated by a single central authority. The transaction can only be carried out by trusted members of the network.

It is only partially decentralized and opaque. There is a centralized authority in charge of everything. A centralized and trustworthy authority is in charge of giving approvals and providing authorized parties access to the ledger in a private blockchain. The most significant benefit of a private network is that it is transparent only to those who are actually inside the business, not to those who are on the outside.

4 Challenges in the Healthcare Sector

Regardless of age, gender, or community, providing high-quality healthcare is considered a basic need. The healthcare system faces significant obstacles in delivering high-quality services.

1. Healthcare regulatory changes.
2. Data management.
3. Data security and integrity.
4. Inefficient administration.
5. Information and integrated health services.
6. Cybersecurity.
7. Rising healthcare costs.

5 Benefits of Using Blockchain Technology in Healthcare

5.1 Single, Longitudinal Patient Records

Longitudinal patient records, including inpatient, ambulatory, and wearable data, can be created using blockchain, allowing clinicians to come up with better ways to provide care by compiling episodes, illness registries, lab reports, and treatments.

5.2 Master Patient Indices

When working with medical information, it is common for records to be mismatched or duplicated. Furthermore, each EHR has a unique schema for each region, resulting in a variety of methods for gaining access and exploiting even the most basic data sets. All data collection, not just the primary key, is hashed to a ledger with blockchain. The user will search for the address; there could be several addresses and keys, but they would all refer to the same patient identification.

5.3 Claims Adjudication

Since blockchain is a validation-based exchange, the claims can be instantly verified, and the network can determine how a contract is implemented. There will also be less mistakes or frauds since there would be no central authority.

5.4 Supply Chain Management

Healthcare companies may use blockchain-based contracts to monitor resource cycles throughout their full lifespan, including when the operation is progressing, whether the contract is operating, and whether any delays have occurred.

5.5 Interoperability

The concept of blockchain, interoperability, can be realized by using sophisticated APIs to render EHR compatibility and storage systems. If the blockchain network was shared with licensed providers in a secure and coordinated manner, the cost and burden of data reconciliation will be removed.

5.6 Tracing and Securing Medical Supplies

With complete transparency, blockchain can assist protect and identify the trail of pharmaceutical supply. It can even track the labour expenses and carbon emissions associated with the production of these items.

5.7 Data Security

The blockchain's secure characteristics can significantly improve the security of health data. Each person has a public identification or key and a private key that can only be opened when and for the length of time required.

5.8 Faster, Cheaper, Better Patient Care

Blockchain has the potential to build a single system for storing and retrieving health records in a secure and timely manner by authorized users. Countless mistakes can be avoided, faster diagnoses, and interventions are possible, and treatment may be individualized to each patient by eliminating miscommunication between different healthcare personnel involved in caring for the same patient.

5.9 Tracking Diseases and Outbreaks

The special attributes of blockchain can aid real-time disease monitoring and disease pattern investigation, which can aid in determining the disease's source and transmission patterns (Fig. 2).

Aside from these, blockchain has the potential to revolutionize sales cycle management, drug supply management, and fraud prevention.

6 Blockchain Platforms Used in Healthcare Applications

A blockchain is a series of data-storage blocks. From medical records to pharmaceutical supply chains to smart contracts for payment processing, the blockchain revolution has a huge opportunity to drive digital transformation. Every modern healthcare system is built on the foundation of electronic medical records. With each

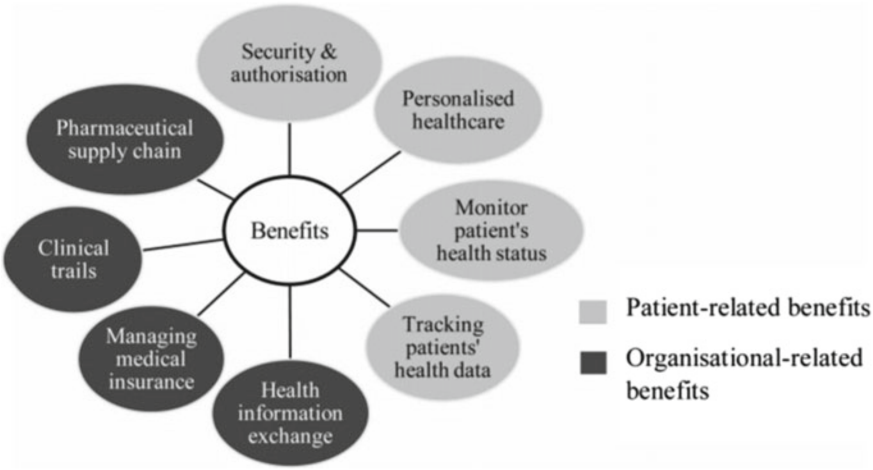

Fig. 2 Benefits of blockchain in medical sector

visit to the hospital, medical records, on the other hand, get longer and more complicated. Each hospital and physician's office appears to have its own record-keeping system. It is difficult for healthcare providers to obtain them. Blockchain is the only solution to these problems. With blockchain, data is more stable. Quorum, Hyperledger, Ethereum, EOSIO, Corda, and IBM are some of the most common blockchain platforms. One of the most crucial steps in beginning to plan and develop a proper blockchain health initiative is to choose the right underlying blockchain framework. The following are the two main platforms.

8:1 Ethereum

Ethereum is a network that is open to the public. It is an open-source, decentralized blockchain with smart contract features, which means it is a background-running computer program. The first blockchain platform to implement the concept was Ethereum, which is why it is so famous for creating smart contract-based decentralized applications like healthcare apps. All of the Ethereum system is transparent, which adds a layer of protection for each and every user. Even if it is open to the public, no third parties will be able to view it, so it is clear that no one can make adjustments to the ledger, ensuring that no corrupting actions will take place without anyone knowing. Patient information and medical records. In the creation of healthcare apps, privacy is a critical concern. It is not necessary for all transactions to be fully open to everyone. Ethereum has some drawbacks when it comes to designing healthcare applications. It has a poor transaction throughput and is thus more vulnerable to cyber-attacks. The Ethereum system has a high transaction cost and a slow efficiency. For patient-managed medical data networking systems, MedRec and Patientory recommend using an Ethereum-based platform. According to Nebula Genomics, genomic data is exchanged and analysed using an Ethereum-based blockchain network. Clinical systems, such as medical data exchange and electronic remote client tracking, have also been proposed for Ethereum.

8:2 Hyperledger

Hyperledger Fabric is a blockchain technology platform that has been used to create blockchain-based medical record management systems. Hyperledger Fabric is a flexible, safe, and adaptable infrastructure. As opposed to other architectures, Hyperledger Fabric provides the most comprehensive approach for designing healthcare applications. It is well-equipped for sensitive and confidential data operations. This technology is well suited to dealing with traffic congestion. As a result, benefits such as open-source, high-quality code, modular design, and high performance make it more profitable. Hyperledger Fabric is permissioned, which is a key feature. The private blockchain, unlike the public blockchain, is not available to everyone. The person who wishes to gain access must first obtain permission. Multiple channel support, which restricts data access to some consortia members, and private collections, where data can be shared peer-to-peer and stored in private databases, but only accessible from chain code on registered peers and hashed to verify authenticity, are key components in ensuring data fabric privacy. Since a permissioned blockchain is a closed system, Hyperledger Fabric safeguards patients' privacy and confidentiality while also keeping medical records safe and up to date. Participants have individual personalities and are familiar with one another. Fabric's smart contract programming supports a number of programming languages, including Java, Node.js, and JavaScript.

The Hyperledger network is suggested for use in an oncology clinical data exchange system for patient care. Hyperledger was also used to create a system for enforcing Institutional Review Board rules. Hyperledger is now being considered for a mobile healthcare application as well as medical data management and access applications. Hyperledger has developed a working group to promote technological and business partnerships for healthcare blockchain applications.

7 Merits and Demerits of Blockchain Platforms in Healthcare

7.1 Merits

7.1.1 Hyperledger Fabric

For a wide variety of industries, Hyperledger Fabric facilitates distributed ledger solutions on permissioned networks. Its modular architecture maximizes blockchain solutions' security, resilience, and flexibility.

Permissioned Membership

Hyperledger Fabric is a permissioned network architecture with known identities for all members.

Performance, Scalability and Level of Trust

The Hyperledger Fabric platform is based on a modular architecture that divides transaction processing into three stages: distributed logic processing and agreement ("chain code"), transaction arranging, and transaction authentication and commitment. There are several benefits of this separation: it requires less levels of confidence and verification between node types, and it improves network scalability and efficiency.

Data on a need—to—Know Basis

Businesses need privacy of some data elements due to competition, data security rules, and regulations on personal data confidentiality, which can be accomplished by data partitioning on the blockchain. Channels, which are powered by Hyperledger Fabric, allow data to be shared with only those who need to know.

Rich Queries Over an Immutable Distributed Ledger

For the blockchain application, the ledger is a sequenced archive of state transitions. Each transaction generates a collection of asset key–value pairs that are generated, modified, or deleted in the ledger. The peer's file system, which also has LevelDB embedded, is appended with the timeless source of truth for v1.0.

Modular Architecture Supporting Plug-In Components

The Hyperledger Fabric architecture's modularity allows network designers to plug in their desired component implementations, which is a benefit. "Bring your own name" is one of the most requested fields for modularity. Some multi-company networks also have identity management in place and choose to reuse rather than recreate it. Consensus or encryption, where certain countries have their own encryption protocols, are other elements of the architecture that can be conveniently plugged in.

Protection of Digital Keys and Sensitive Data

Support for HSM (Hardware Security Module) is important for securing and managing digital keys in order to provide effective authentication. For key generation, Hyperledger Fabric supports both updated and unmodified PKCS11, which helps with cases like identity management that need more protection. HSM improves the security of keys and confidential data in situations involving identity management.

7.1.2 Ethereum

Ethereum provides interoperability with technologies that have the potential to transform the healthcare industry. Among other blockchain applications, it allows data security, approval control, medical tool, and product tracking.

Decentralization

After Bitcoin, Ethereum is the world's second most decentralized cryptocurrency. There is no centralized body in charge of anything. This distinguishes it from other smart contract systems such as NEO and Tron. The ultimate defence against intrusion is to use a decentralized network like Ethereum.

A Robust Developer Community

Ethereum has the world's biggest developer group, far bigger than Bitcoin. As a result, Ethereum has a significant advantage over other protocols. Blockchain-based cryptocurrencies are still a relatively young technology, and much work remains to be done in order to make crypto useful to the average citizen. Ethereum will be the first project to achieve product-market fit, paving the way for widespread adoption.

Interoperability

When we create an app on Ethereum, we can link it to hundreds of other protocols right away. This is referred to as money legos in the Ethereum culture.

7.2 Demerits

7.2.1 Hyperledger Fabric

1. It lacks highly qualified programmers.
2. It has a dearth of use cases.
3. It has a complex structure.
4. It comes with the bare minimum of APIs and SDKs.
5. It is not a fault-tolerant network at all.

7.2.2 Ethereum

Ethereum is a fantastic forum, but it is far from flawless. Here are some major issues that Ethereum is currently dealing with.

Slow Speeds

Decentralized protocols, such as Bitcoin and Ethereum, are notoriously sluggish. Bitcoin has an average transaction speed of 7 TPS, while Ethereum has a speed of 15 TPS. That is twice the speed of Bitcoin, but it is not nearly fast enough.

The Programming Language

Solidity is a programming language used by Ethereum developers to build apps and tokens. This is a brand-new programming language with a number of well-known flaws. In practice, this means that developers may have to write smart contracts in a new language that they may not be familiar with. As a consequence, it is relatively normal for smart contracts to be written with security flaws.

Unstable

The Ethereum blockchain is still undergoing a number of changes, including switching from a PoW to a PoS consensus process.

Dependability

ERC20 tokens, like every other token, are based on Ethereum and built on top of it. This poses a danger, given that Ethereum is constantly changing.

Hard Forks

Since you are reliant on another blockchain, there is a chance you'll run into problems due to hard forks.

Sovereignty

Since the tokens are built on the Ethereum blockchain, there is no way to influence their future growth. The program and use case should determine whether or not ERC20 should be used.

8 Hyperledger Verses Ethereum: Key Difference

8.1 Purpose

The main difference among Hyperledger and Ethereum is how they are supposed to be used. Since smart contracts are decentralized and open to the public, Ethereum can run them on the EVM for applications.

Hyperledger, on the other hand, uses Blockchain for industry. It can also promote the use of pluggable components to improve security, robustness, and flexibility. Hyperledger is also built on a standardized system giving users a lot of flexibility about how they utilize it.

8.2 Mode of Accessibility

You do not need permission to use Ethereum because it is a public Blockchain network. Anyone can install the Ethereum platform in order to participate in Ether extraction as well as explore and monitor the network's transactions.

Hyperledger maintains strong access control. The platform and its resources are only accessible to registered members. Furthermore, before joining the Hyperledger network, each participant must obtain permission.

8.3 Confidentiality

Ethereum, as previously said, is a decentralized system which does not need any permissions in order to run. All activities are recorded on the Blockchain network and are available and open to all peers, making it clear and transparent.

Hyperledger, on the other hand, is a permissioned blockchain network that is extremely stable. They can only be seen by people who have been granted access to a network transaction. You must first obtain permission to access a specific service on the Hyperledger system.

8.4 Programming Language

The programming language is another significant distinction between Hyperledger and Ethereum. Smart contracts, which are composed in steadiness, a strong contract-oriented language, are used by Ethereum.

Smart contracts generated by Hyperledger are referred to as "chain code." The chain code can also be used to execute business rules that the network participants have settled on. After that, it is known as a smart contract. These chain codes are developed in Golang, a Google-developed computer language.

8.5 Consensus Mechanism

Users can choose from a number of consensus protocol in the Hyperledger Fabric venture, including the Kafka consensus algorithm. It also provides protocols for Solo and Raft. Raft is crash-tolerant, whereas the Solo parameters are suitable for programmers.

In the Ethereum consensus scheme, an improved version of the proof of work method is used. Even though the Ethereum consensus method is extremely powerful and reliable, it consumes a significant number of resources and can cause delays. On the other hand, the Ethereum consensus method PoW is considered to be better to the Raft protocol

8.6 Cryptocurrency

Ether is the native or built-in token of Ethereum. Each participant can mine for ether by paying gas.

Hyperledger does not have its own cryptocurrency, and mining for it is not needed. This improves the network's usability and enables it to handle large interaction rates allowing it to automate business processes all over the network.

Figure 3 Contrast of two Blockchain technologies (Ethereum and Hyperledger Fabric).

9 Technical Requirements

When it comes to selecting a technology stack for designing healthcare applications, there are several considerations to consider. It is vital to evaluate the functional specifications for health information technology systems when contrasting the various blockchain systems used in building new applications. The conditions for various healthcare use cases vary, but there are certain issues that are universal. These problems are briefly discussed in this section, and they are used to defining and compare the most widely used blockchain systems for medical record management in the following section. The top priority in developing a healthcare application is the patient safety and their data on health conditions. According to the existing blockchain model, not all transactions in health care should be entirely available to all. There are constitutional and regulatory standards that must be met

	Ethereum	Hyperledger Fabric
Description of Platform	Modular blockchain platform	Generic blockchain platform
Governance	Ethereum developers	Linux Foundation
Privacy features	Private transactions, experimental zero-knowledge proofs	Private channels, private transactions, zero-knowledge proofs
Security	Public, but supports permissioned networks	Permissioned, granular access control, less prone to attacks
Consensus	Compute-intensive PoW, PoS	Multiple approaches
Speed	15 transactions per second	3000 transactions per second
Scalability	Low transaction throughput	Higher transaction throughput
Transaction cost	High	Low
Incentive	Cryptocurrency required	No cryptocurrency required
Smart contracts	Solidity	Java, Node.js, Go, Higher-level abstraction (composer, JavaScript)
Currency	-Ether -Tokens via smart contact	-None -Currency and tokens via chain code

Fig. 3 The contrast of two blockchain technologies

when processing healthcare data. The European General Data Protection Regulation (GDPR) sets stringent guidelines for the processing of patient data in order to protect patient's privacy. As a result, any blockchain architecture that is used to build systems and applications should have a comprehensive collection of confidentiality features. To avoid data theft in any form, HIT systems must be designed and installed. Any entity in the application should be identifiable, as well as its activity. The legislation mandates that security requirements for healthcare apps, including anonymity, be met. Know your consumer (KYC) and anti-money laundering (AML) strategies, for example, necessitate the knowledge of real-world identities through business systems. To monitor how users communicate with the service and the activities connected with it, strong authorization capabilities and detailed access control mechanisms are required. Transaction efficiency is another factor to consider when selecting a user interface for building health systems. Healthcare technologies must be scalable in terms of consistency and transaction performance in some cases, such as remote patient monitoring (RPM) systems. The total number of transmissions involved in the agreement process determines the transaction throughput or scalability of blockchain frameworks. How transactions on the blockchain Web are authenticated until they can be recognized as legal contracts is consensus is concerned. As a consequence, the various Blockchain frameworks' methods for achieving consensus are essential considerations. Another critical aspect to consider when selecting technology platforms for designing healthcare applications is operational price. Medical solutions must be set up on networks with consistent and transparent transaction prices, if not no costs in any respect. Finally, the blockchain platform that would be used to build healthcare applications must be able to facilitate smart contract execution. Smart contracts, as previously mentioned, are not a core feature of blockchain, but their use will aid in the coding and reconstruction of the set of rules that control relations between the various roles in the healthcare sector.

10 Limitation

The study's main drawback is that we only compared two platforms, so the scope may be restricted. However, based on our findings, an informatics researcher, IT specialist, or a technical head in healthcare or other institutions may access various functional aspects of the platforms, such as setup/learning time and technical features. The correct platform is chosen based on the application's specifications. For example, Ethereum maintenance and Hyperledger Fabric fine-grained access control.

11 Conclusion and Future Work

This work emphasizes the advantages of blockchain in healthcare and which platform is better in managing healthcare information, whilst additionally acknowledging that these advantages have been slow to arrive due to Blockchain's early stage of growth and dependence on cryptocurrency-based solutions.

According to a review of the literature on blockchain-based healthcare applications, two major blockchain systems are widely used in the development of these applications. The identified frameworks were compared to the needs of healthcare applications with the intention to aid health informatics researchers, clinicians in deciding on the best network for building medical applications.

Both Hyperledger and Ethereum, according to our research, are extremely versatile, but their strengths lie in different areas. Ethereum is a generic framework for any application thanks to its strong smart contracts system. However, it is clear and does not need permission which has an impact on the performance, scalability, and safety.

Hyperledger, on the other hand, uses a permissioned way of operation and authentication to address efficiency usability and security concerns. We can also tailor Hyperledger to a variety of applications, almost like a toolbox.

Hyperledger Fabric contains more layers in its network to increases manageability and security, which can result in long setup time compared to Ethereum. The installation of the software Ethereum are also easier comparing to Hyperledger Fabric.

Considering the healthcare applications, the characteristics of the two platforms are follows

Ethereum is supported and maintained by a huge group of developers from all over the world. Because of this openness, Ethereum is a good option when it comes to the long-term viability of the network on which the applications are built. While Ethereum does not support private networks, it can still send and receive personal and private data. Private data may be stored off-chain in these situations, with the best guidance to the facts being registered on a public network. As a result, only the data's pointers are accessible to network members, while the real private data is hidden from all but approved users.

Hyperledger Fabric is well-designed, multi-layered access control framework along with Hyperledger Fabric's own certificates leads to high versatility, security, and manageability of the Blockchain platform. It is mostly used for everything on the blockchain network, including the exchange of monetary value. For order in minimal specifications, a chain code is executed on proportion-based transactions. It improves the trustworthiness of the connection. It also enhances network scalability and consistency. It is a public ledger that is encoded. It has SQL-like querying capabilities. It is simpler to appeal and check the decision. At the enterprise stage, it is extremely adaptable and scalable. It is yet another reputable blockchain platform. On any blockchain network, it could share a variety of properties. It offers a high level of confidentiality. It engages in a variety of multilateral transactions.

Hyperledger Fabric is a permissioned blockchain technology framework that has been actively employed in the implementations of blockchain-based systems for healthcare data management. To ensure privacy of data subjects, Fabric mainly relies (i) on multiple channels support, which make it possible to limit the access to the data to certain participants of the consortia, and (ii) on private collections where sensitive data can be exchanged peer-to-peer and stored in the private databases, yet accessible from chaincode on authorized peers and hashed to verify authenticity. Storing only hash on-chain is also used to provide verifiability of vast amounts of anonymized data for data-driven research and applications.

Therefore, **Hyperledger Fabric—this Blockchain architecture has the most potential for medical application growth and healthcare record management**. Because in healthcare sector data privacy and security is most important. With the help of Hyperledger we can easily maintained our data also.

In the future, the Hyper Fabric will be used to construct an application for a specific healthcare use case, with the output being tested to better understand and illustrate the Hyper Fabric's scalability, latency, and throughput. In the future, data sharing through various blockchain networks will be a fascinating research subject.

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