PROPOSED BLOCKCHAIN AND CLOUD BASED FRAMEWORK MODEL FOR ELECTRONIC HEALTH RECORD MANAGEMENT (BC-EHR) FOR DEVELOPING COUNTRIES

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Abstract

The verification, maintenance, and synchronization of electronic medical information has long been a challenging challenge in the medical system. Furthermore, the random broadcast of patient records would present a variety of hazards to patient privacy. Therefore, the question that has to be answered is how to enable safe data exchange while yet protecting the personal privacy of consumers. In recent years, blockchain has been suggested as a potentially useful way to facilitate data exchange while maintaining both security and privacy. Consequently, a plan for the searchable distribution of electronic medical records was presented, and it would use blockchain technology and smart contract software. In the actual world that we live in today, the healthcare system is important, but it is also challenging and overloaded. Using blockchain technology and enhanced health record administration have the capacity to manage medical data, they can ensure the safety of patients by recording and keeping records in their medical histories. This allows for the patients' medical histories to be monitored more closely. A comprehensive look at the patient's history as well as the information that has been gleaned from their medical records is required in order to get an understanding of the severity of various diseases and to evaluate the treatment options that have been used in the past. Sharing medical records within the context of the present-day healthcare system may become more secure, efficient, and transparent thanks to the potential applications of blockchain technology.

In this paper the use of recent developments in computer technology to suggest an innovative EHR (Electronic health record) architecture for the storage and transmission of medical information has been discussed. These are only two examples of potential applications. The interaction process works its way through its phases in a methodical manner, which enables you to offer better results. Statistics are saved in a particular tokenized format for use in the future, and these formats are compatible with each other. It has been shown that incorporating blockchain technology into existing healthcare infrastructures paves the way for a significant increase in the number of opportunities for advancement.

1. Introduction

EHR is an abbreviation for "electronic health record," which refers to a digital copy of a patient's official medical record that is capable of being exchanged quickly, safely, and easily across a number of different medical institutions and departments. It includes all of the information that is necessary to acquire the patient's information, such as the patient's medical history, radiological photos, diagnoses, prescriptions, vaccination dates, treatment plans, allergic reactions, and laboratory results. Because it enables quick access to patients' medical records, which are considered throughout the treatment decision-making process, it plays a vital role in the healthcare industry. As a result of developments in computer technology, the majority of medical institutions have transitioned away from using a paper-based system in favor of an electronic health record (EHR), which allows for the maintenance and transmission of medical information[1].

Up until the 1960s, all medical records were kept and recorded on paper, and the filing process was done by hand. Today, electronic records have mostly replaced paper records. All of the lab results, diagnoses, medicinal medication directions, and visit notes were saved and recorded on contemporary paper sheets. These paper sheets were then collected together in order to keep track of the patients' information. In addition, these medical records were retrieved and organized using shelves that were designed specifically for the purpose of holding the file folders associated with these data. After then, in the 1960s, things started to change with the introduction of computerized medical record systems. Since then, things have continued to evolve.

In the beginning, electronic health information was used for the purpose of shifting facts for the purpose of declaring processing and scanning photographs in order to acquire papers. Because it did away with the processes of retrieval and submission of files or charts, controlled the position of the chart, and photocopied the chart, this adjustment was seen to be beneficial and save time. By using the approach of graphical representation, facts may be shown in a way that is easy to understand and clear. Workstations for microcomputer networks had been developed further in order to improve the process of transcribing all of the EHR-related patient orders. As an immediate consequence of this, there was a full-size decrease in the expenditures associated with both individual patients and the whole hospital[21].

patient information may be easily accessed owing to computerized record management, which can be connected to tracking equipment for the goal of gathering and analyzing patient data included inside an electronic health file (EHR). After some time had passed, electronic health records (EHRs) began to be used in significant numbers for the purpose of keeping scientific data. This was done in the cause of improving medical care. These electronic health records also proved valuable to epidemiological investigations. The secondary use of EHR information, on the other hand, surprisingly revealed flaws or issues with the majority of the collected data for analysis and assessment[20]. This was the case because of the nature of the subordinate use.

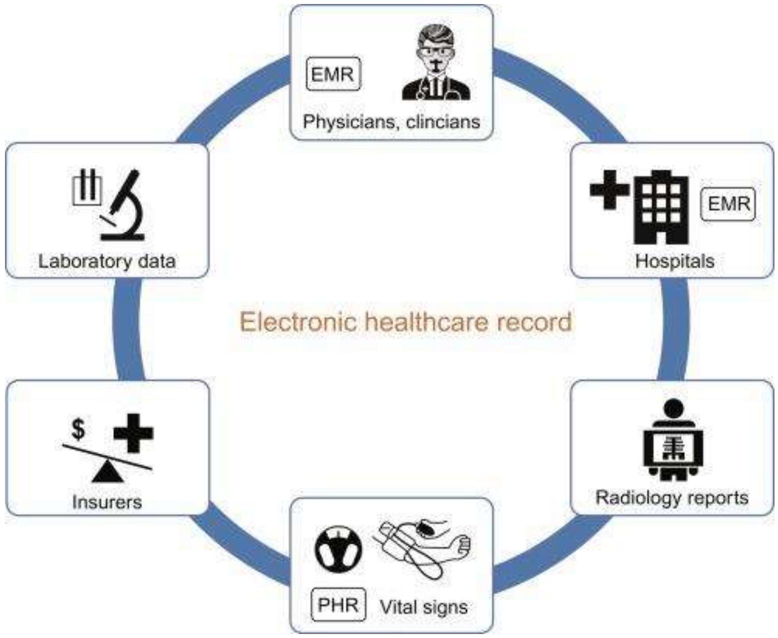


Fig1.- General Outlook of EHR

The vast majority of electronic health records (EHRs) in use today are constructed using a web/client-server architecture[2]. These electronic health records (EHRs) provide access to patient records, relational databases, and entry displays that users may navigate with the use of pointer devices and mouse scrolling. The year 2009 marked the beginning of a significant increase in the usage of electronic health records (EHR) inside the United States. It is currently common practice for data relating to healthcare to be exchanged automatically from one branch of a medical organization to another, and a large number of medical organizations have created HIE and EHR networks[19].

Over the course of the previous several years, there have been significant developments in EHR; despite this fact, the majority of people's earlier expectations have not been met, and existing EHRs need additional improvement in order to meet the demands of the fast changing healthcare environment. Improvements in electronic health record technology will help facilitate the supply of interoperable systems that adhere to international standards[6].

The phrase "blockchain" refers to the digital record of a transaction that is kept on a computer. Blockchains is the term that's used to refer to this technology because of how it's structured[4]. A sequence is the arrangement of individual information, also known as blocks, which may be associated to one another, in an incredible succession; this arrangement is termed a sequence. Every transaction is added to the blockchain once it has been validated by a large number of validating nodes that are connected to one another. This is the easiest way for the transaction to be added. The blockchain is a fantastic example of an allocated ledger from the period (DLT), which is short for distributed ledger technology. A network that is connected to peer-to-peer transactions is comprised of these networks, which are arranged to keep an eye on the many different kinds of blockchain transactions .Before adding a transaction to the blockchain, they make a concerted effort to check if it has been confirmed and then validate each transaction individually. This decentralized network of computer nodes performs a check to ensure that a single unit has not connected invalid or unwanted blocks to a specific chain[17].

Interoperability and the open exchange of information between parties helps to encourage high-performance information transfers, which in turn leads to better patient outcomes, an improved fitness reputation, a decrease in the number of repeated processes, and a simplification of ambiguity. [3] When discussing electronic health records (EHR), the word "interoperability" is used to refer to the ability of a variety of systems and devices to communicate with one another and comprehend information that is transferred between them. The process of making decisions in the scientific community may benefit from having such an awareness of the information that is being presented. Encryption for privacy and safety is currently being researched in the hopes that it may one day be able to protect the confidentiality of documents[5]. The maintenance of the confidentiality of exclusive health information is supported by three pillars: the protection of private health information through administrative protection methods, the protection of open health information through open safety measures, and the protection of physical health information through physical safety procedures. What is meant to be referred to as "privacy" within the context of healthcare is what is meant by the term "privateness," and the term "privacy" is what is meant by using the term "privateness." Medical professionals who have frequent encounters with a patient's medical history have an obligation, either morally or legally, to protect the patient's privacy[4].

The CCF places an emphasis on the significance of regulation. Data exchange, often known as the transfer of medical records, is an absolute need in situations in which the treatment of a patient is dispersed among many medical institutions. It will encourage the majority of physicians to investigate the patient's past medical conditions in order to arrive at the most accurate diagnosis possible and to prevent the need for superfluous diagnostic and radiological tests. The sharing of data within the community may be broken down into one of three categories, according to the participants[13]. Within the medical organization, the knowledge is passed around and discussed. In addition, the patient, as well as any close friends or family, are informed of the specifics. In the end, the material was sent to several medical organizations as well as the government. Every electronic health record (EHR) has to have the data it requires in order to function effectively. In addition, the safety procedures and communication networks that are required to access them, must all perform effectively[16].

2. Literature Review

Gordon and Catalini[24] conducted research into the many ways that blockchain technology could be able to assist the healthcare sector[24]. They came to the conclusion that the healthcare industry is controlled by pharmaceutical companies, hospitals, and other entities with vested interests. They emphasized the capacity for information sharing as the primary driving factor for the use of blockchain technology in the healthcare business. This study also discovered four strategies or characteristics of the healthcare industry that need to be modified in order for the sector to embrace blockchain technology. Among them are processes for dealing with digital access rights, the accessibility of data, and gaining clinical information and patient identities more quickly.

C. A. Ardagna, S. De Capitani et al. [12] research was conducted to get a better knowledge of the possible solutions to the scalability challenge given by the development of blockchains, as well as to identify efforts that attempt to address the problem. When people talk about the concept of blockchain, what they really mean is that blockchain is a set of computational and financial principles that are formed on a peer-to-peer network. The purpose of this study changed into to determine which kinds of records need to be saved on the blockchain and which kinds of data may be stored outside of it. The results of this study presented five distinct off-chain data storage patterns, together with the underlying standards and implementation approaches for each of these patterns. The study was carried out to investigate the feasibility of using blockchain technology to store data.

S. Tabrez Siddiqui, M. Shuaib et al.[18] the authors believe that the landscape of information technology is continuously shifting, and that the use of blockchain technology to information systems would be helpful. They characterized bitcoin as a decentralized peer-to-peer community that enables users to carry out financial transactions using bitcoin as the medium of exchange. In addition, a definition was offered for the evidence-of-paintings consensus process, in addition to a description of the concept of mining for the blockchain. The authors emphasize that scalability is a significant issue for blockchain and that numerous solutions have been proposed to overcome it.

P. Palvia, T. Jacks et al[22]. centered on the concept of smart contracts and how such contracts may be implemented using blockchain technology. They start out by defining fundamental concepts related with smart contracts, such as how they operate, the underlying architecture, and any other relevant operating systems. The authors also discuss the potential role that smart contracts may play in the newly proposed idea of parallel blockchains. They claim that the goal of using smart contracts in blockchain is to achieve decentralization, which can be accomplished with the assistance of programming language code that is kept secure inside the smart contracts. Following a brief introduction to the principles of smart contracts, the author shifted the focus to the many levels of the blockchain and the ways in which its components communicate with one another to ensure the continued viability of the system. The several phases are as follows: the facts layer, the network layer, the consensus layer, the incentive layer, and the contract layer.

F. Girardi, G. De Gennaro et al.[23] evaluated a variety of possibilities for blockchain technology in the healthcare and biomedical industries. The authors came up with the idea that using blockchains in this industry provides a variety of benefits, some of which are decentralization, the permanence of scientific or medical facts, data provenance, and the accessibility of enduring knowledge. These are only some of the advantages of doing so. In addition, the authors revealed that stakeholders operating within the biomedical or healthcare industries may also have access to private data that were made available to them. The ability of blockchain technology to retain anonymity, along with its velocity, scalability, and the possibility of being susceptible to a 51% attack, are some of the capacity limitations that have been called into question. As a consequence of this, they have a somewhat sizable market share in certain sectors. The authors suggested that one potential solution to these problems could be to store sensitive medical records off-chain, encrypt them to maintain their safety and secrecy, and then use VPNs (virtual private networks) to protect themselves from adversarial attacks. This would be a viable solution, according to the authors. One step closer to resolving the issues that have been pointed out would be taken if this were done. This will prove to be an effective strategy for overcoming the problems that are now being faced.

C. S. Kruse, B. Smith et al. [10] They suggested combining the decentralization made possible by the blockchain era with the scalability made available by using the underlying Hadoop database in order to get around the scalability problems that are inherently associated with the blockchain era. This was done with the goal of escaping the scalability problems that are inherently associated with the blockchain era. They came to the conclusion that the best approach would be to use one that included the development of a mechanism, which also involved adding the blocks to the Hadoop database. The blockchain that was developed on top of this framework has all of the basic features that are necessary for a blockchain to feature effectively. These traits are necessary for a blockchain to function well. despite the fact that they are kept inside the Hadoop database in an effort to achieve the highest scalability possible at the lowest possible cost, the blocks. According to the findings of this study, one solution to the problem of scalability that plagues the blockchain platform is to use the Hadoop database management tool in conjunction with the SHA3-256 hashing method for transactions and blocks. This combination is called a scaling solution.

3. Proposed Methodology

It is a game-changing piece of technology that has the potential to significantly speed up the process of managing patient information by offering an unrivaled level of computing performance, as well as imposing trust in a manner that is both safe and secure. This could have a significant impact on the healthcare industry. Because it offers a degree of processing efficiency that has never been seen before, Blockchain technology might potentially result in significant time savings for the management of patient information. This would be the case if and when it was implemented. In addition to this, it already has a number of important qualities due to the fact that they were built into its structure. The decentralization of the garage and an emphasis on openness are two of the aspects that are included here.

It brings administrative costs down to a more manageable level, particularly those that aren't completely necessary to the operation of the business. The blockchain is predicated on a number of primary ideas, the most essential of which are peer-to-peer networks, public key cryptography, and consensus procedures. Those are the ideas that make up the blockchain. These are only a few of the many criteria that go into the formation of the concept of the blockchain generation. A blockchain's permissions system may be used to categorize it into one of three categories: public blockchains, personal blockchains, or consortium blockchains. Each of these categories is described in more detail below. Each of these classifications is referred to as a "kind." In order to reach a consensus among everyone who uses a public blockchain, any person who has access to the internet is eligible to take part in the process. This is because everyone can see and verify the transactions that take place on the blockchain[14]. This is as a result of the fact that the blockchain is available to everyone. Both proof-of-paintings and proof-of-stake are examples of different types of protocols that may be used to ensure the integrity of public blockchains. The insertion of incentives and the verification of encrypted numbers are both made possible by these protocols. The identities of anybody who participates in the public blockchain device are concealed in a way that maintains the system's appearance of anonymity[15]. This is done in order to protect the integrity of the blockchain. This is done so that the gadget may continue to provide the impression that it is unnamed even after it has been given this information. Having said that, it is possible for anybody to see the whole public blockchain architecture. In the case of personal blockchains, there is only one organization that has total control over the operation of the network as a whole. This control may be used in any way that the organization sees fit.

The study that is being suggested focuses mostly on using blockchain technology to problems that arise in hospital administration. The presented code pattern illustrates very clearly the platform for access control as well as the medical data that was constructed utilizing blockchain technology.

Four main Layers which are used in this platform of application:-

(1) Layer 1 Solution admin (blockchain operator): It is the first layer, and the administrator of the response presents the major challenge for that layer. This administrator of the answer is the domain of the hospital institution, and he is one of the hierarchies that has the best diploma of power to acquire admittance to the whole control institution. The hospital institution is the domain of this administrator of the answer. In addition to this, he is one of the hierarchy involved in the pricing of the solution. In addition to that, he is the administrator of the section of the site that has the answer, which can be found here. Because of this, hospitals now have the ability to affiliating themselves with a brand new corporation and selecting medical institution directors who will report to the monitoring dashboards of the brand new employer. This ability was made possible as a consequence of the aforementioned. This particular administrator of the solution has been granted full authority.

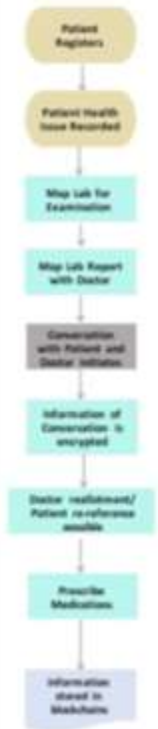
(2) Layer 2 of the organization hospital as an administrator: the job that an organization administrator plays inside the organization is to be responsible for the upkeep of a specific hospital, which is a component of a group of hospitals. This administrator has the ability to either delete the users who are under his supervision or join the new workers and put them in charge, for example in the role of a doctor. The overall administration of a certain medical facility is within the purview of this entity.

(3) Layer 3 Doctor pharmacy lab as user: Here, in the third layer, the doctor is shown as a user within the company. This user has a relevant vital position within the company and has the ability to upload the data of their patients. He is also granted the power to read or download it to their patient records, and he has the capability to download or examine the statistics. in addition, he is given the authorization to read or download it. People who were afflicted by him remember him as being the most remarkable person they have met in their lives. Right now, within the 0.33 layer, the physician is considered to be a person inside the employer who has a relevant critical position and is able to contribute the data of their patients. This is because the physician is able to add information about their patients. He is also given the power to read it or download it to their patient information, and he has the ability to download or see the data. Moreover, he is given the authority to study or download it. Patients of his remember him to be the largest guy they have ever seen in their lives.

(4) Layer 4 Patient as a user: In the end, The ill person is given the appropriate position as a user in the commercial firm that is dealing with them in the appropriate manner. This is done to ensure that the individual's needs are met. This means that the individual being impacted has the ability to add statistics, look at files connected with their records for themselves, examine reports, obtain admission records, control the right of entrance to files, and manage records associated with on the screen in front of them.

4. Methodology Flow Structure:-

i. Firstly the Patients begin their Registration in the system for the validation for the further process.
ii. Secondly, after this registration process the patient reports his/her issues in the system. By which the issues are recorded in this system.
iii. Then after, thirdly after the entry of the issues the reports are mapped for the examination in the lab.
iv. Then, Based on the mapping of the reports ,doctors are recommend for the particular patient.
v. After then the Doctor and patient initiates their conversation regarding the issues qhich the patient is having.
vi. Then if at any stage Patient needs the doctor's suggestion again then the reallotment on the request of the patient is done .
vii. After then Medicines are prescribed for the issues and for the treatment also.
viii. For the future , these records are stored in the tokenized format , so that after the recovery if the patient is having any other issue then records may help doctors to give better treatment.



Patient Registration in the system

Patient reports his health issues in the system

Based on the health issues, the lab tests are recommended to the patient

The lab records are recorded in the system and based on the result, doctors are recommended to the parient.

Doctor and patients consult and the process of diagnosis and prognosis begin.

Doctor reallotment on request of patient or patient reassignment on the request of doctor is possible at any stage.

Doctor prescribes medicines/treatment.

All the data is stored in tokenized format for future reference.

5. Implementation method

1. Ways to login

i. Logging into each user flow partner's dashboard ,the solution manager, hospital administrator, physician administrator, and patient administrator are the first points of contact in the patient flow. The administrator of the solution must first log in to his own dashboard before any of the other directors may initiate the user drift.

ii. To log into the corresponding dashboards and direct users to the login page for their cloud-hosted blockchain solution.

iii. When a user logs into his dashboard, the login portal communicates with an identity issuer over an open API connection to provide him with an on-boarded identification card like Google ID..

2. Admin Dashboard flow

i. Considering that the answer goes with the flow management component starting at the admin stage, customers should now not have any trouble authenticating themselves the use of the login strategies which have been outlined before.

ii. A user who has successfully authenticated may be granted access to the solution's control dashboard. The management API is then used by users to access their domains.

iii. Responds to all user requests from administrators of the “API Blockchain Solution Manager”.

iv. Blockchain platform connected Blockchain Solution Manager has been updated..

3. Organization Dashboard Flow

i. In this case, the administrative workflow at the healthcare facility begins to evolve with the business factor, and it continues immediately to need user identification using the aforementioned channels.
ii. After signing in, folks gain entrance to the sanatorium management dashboard. Using APIs provided by the relevant companies, we may transform users in our hospital analogy from patients to physicians.
iii. To process user queries, the blockchain solution manager has been integrated with all organization APIs.

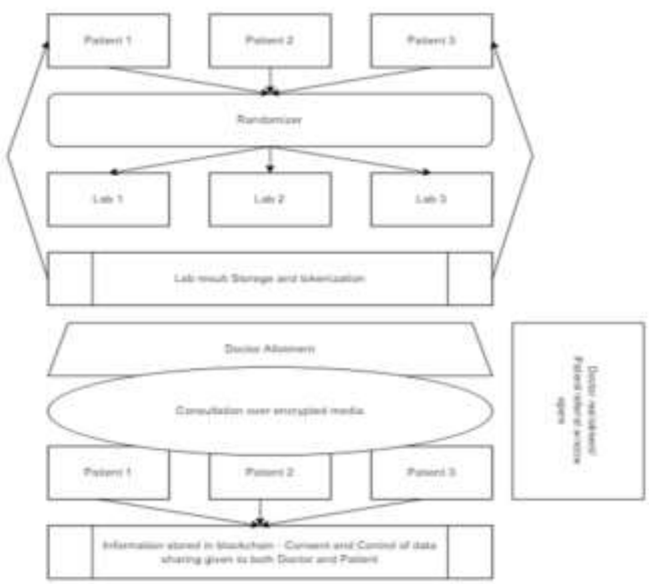
4. Doctor Dashboard

i. The physician flow starts with the physician components, and from this point on, users must authenticate themselves using the aforementioned login methods.
ii. The users can then access the doctor dashboard following their successful authentication. In this situation, they have access to the patient's medical records as a part of the hospital and can download any records for viewing via the medical API.
iii. The document keeps track of the status of this for all patient documentation.
iv. Blockchain document store has integrated the updated ledger with the IBM blockchain operating system.

5. Patient Domain

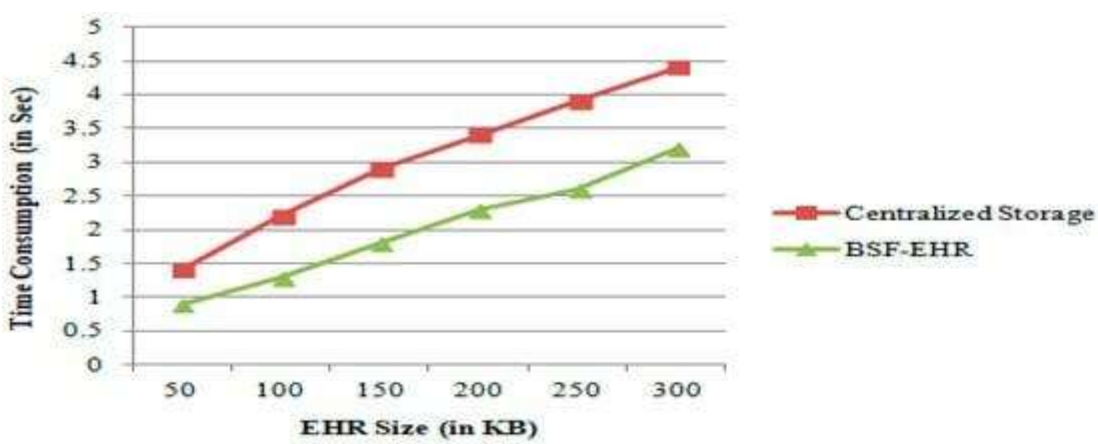
As a result, the users are required to verify themselves by using the login information that was previously provided.

After successfully authenticating themselves, the user is granted access to the patient's dashboard, where they are able to add their own medical data, download any of their medical data, examine the access logs of their documents, and read their documentation by using the patient's API.



Result and Discussion

Is there anything that needs to be prioritized but hasn't been dealt with yet even though it's been brought up? There will likely be a number of obstacles to overcome in the process of integrating blockchain technology into existing healthcare infrastructure. The scalability of the system should be the first concern. While it will be possible to monitor the data that is kept on the chain, the number of patients and parties that participate will continue to grow over time. There is a limit to the amount of processing power and storage space available in a computer system. This might make using blockchain services more difficult. It is possible that this will become a problem as a result of the ongoing growth, scalability, and resource demands of the network. "Rubbish in, garbage out" is another topic that has to be addressed (GIGO). This occurs when a user submits data that is either incorrect or completely at random. In order to process all of this information, the system could provide inaccurate or misleading results. Blockchains in the healthcare industry can run into the same issue. "Garbage" may be included into the record now that the patient is actively participating in their own therapy. The same danger can be posed to a caregiver or other professional who has been given verbal or written clearance to make changes. There will always be malicious users who try to steal data or cause harm by taking advantage of security holes in the system. Even if the blockchain itself is secure, there is still cause for worry over endpoint security[7]. If an end user is compromised, an attacker has the potential to contaminate the blockchain. They could steal information from the person who was hacked and then provide false information so that it can be added to the chain[11].



Can blockchain technology and artificial intelligence work together to provide even higher standards of care for patients receiving tailored medical treatment?

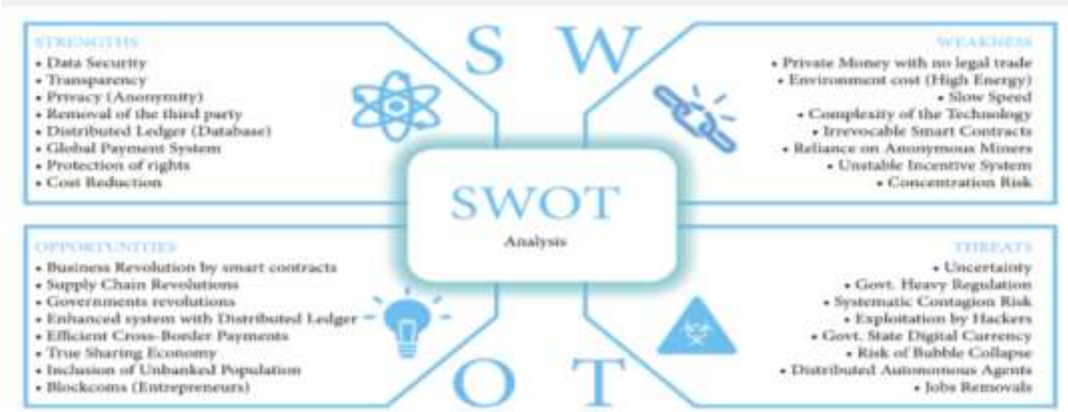
The field of data science is also working to improve healthcare by using the methodologies of artificial intelligence and machine learning. These decisions, like those made by blockchains, are made by computer programmes called algorithms. While blockchains compile data in an effort to ensure the data's integrity[10], AI works toward predicting future events and making sound decisions. A medical diagnosis, medications, and other therapies are all examples of options available in healthcare. Blockchain technologies have led to increased data integrity and the elimination of traditional security risks. It is not possible to send large amounts of data directly over the blockchain without negatively impacting the performance of the system or the data's security. It may be possible to process the data in advance, leaving just the findings and information on the blockchain, if artificial intelligence algorithms are included into the system.

Limitations of Proposed Work

Within the following part, we are going to talk about some of the limitations that the cautionary mission has. It is essential to bear in mind that even though it's almost not possible to hack and tamper with the records that are recorded within the blockchain, this isn't the case of the programming instructions that are protected in the clever settlement. This is something that needs to be stored in thoughts. That is something that has to be kept in mind at all times. It is also possible that even very minor flaws in the programming might cause a domino effect, which could lead to disastrous outcomes. This is a challenge that does not only merit our attention; rather, it demands that we give it our whole attention at this very moment. When using a blockchain community, reaching consensus might be difficult because of the procedure that is used to build agreements. This is one of the components that could make reaching consensus tough. The use of a community like this comes with a number of negatives, and this is one of them. Proposed blockchain platform's implementation of the Byzantine Fault Tolerance (PBFT) mechanism may be rendered inoperable. This is one of the probable outcomes of a situation in which the mechanism is put into action.

SWOT Analysis

A process known as SWOT analysis, which stands for strengths, weaknesses, opportunities, and threats, is used to evaluate the four aspects of the proposed architecture that were discussed before. The following chart presents a comprehensive SWOT analysis of the blockchain-based healthcare system that has been presented[8].



Conclusion and Future work

In the contemporary technological age, the application of blockchain technology is pervasive, which is a hot study issue in recent days. As a result, a significant amount of research effort has been included into this field in order to improve their capabilities and performance. The main focus of the work we want to do is on the use of blockchain technology to the processing of healthcare data. As a result, we research both recently installed methods and cutting-edge issues in the healthcare sector. The use of blockchain technology to improve healthcare management is the main topic of this study. The biological and healthcare sectors may profit from the combination of blockchain generation and AI. The issue with the blockchain-based healthcare management tool is minimized when our study is used, especially the tendency of the traditional blockchain system to have a lower latency. As a result, the suggested method places a lot of emphasis on cutting down on the amount of postponement. The preservation of electronic medical records, or EMRs, is a crucial factor that needs attention. Because of the digitalization of patient data, scientific data are actually simpler to disseminate and keep. Concerns about unauthorized access and disclosure, a centralized system that may be considered a single point of attack, and segmenting patient medical information in the event that several healthcare providers are consulted still exist[12]. Blockchains, a kind of technology that was originally introduced with the launch of Bitcoin[9], are becoming more popular among academics as a potential solution to the issues that have been identified. In an effort to improve the functioning of the existing healthcare system, researchers have begun examining the many ways in which blockchain technology may be used. Because of its characteristics of being irreversible, transparent, distributed, and decentralized, blockchains have the potential to be employed as a digital ledger. This would make it easier for patients, caregivers, and insurance companies to communicate with one another. It is also feasible to combine all of the relevant patient information into a single file, which not only makes the information more comprehensive but also gives caregivers a clearer picture of the patient's past medical conditions.

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