Revolutionizing Healthcare: Enhancing Interoperability and Security in Personal Health Record Management through Solana Blockchain and Custodial Wallet Architecture

Chirag Goel[1*], Kunal Chhabra[2], Samyak Jain[3], Dr. Neetu Goel[4], Dr. Sudha Narang[5]

[1] Student of Btech(CSE), MAIT, Delhi
[2] Student of Btech(CSE), MAIT, Delhi
[3] Student of Btech(CSE), MAIT, Delhi
[4] Assistant Professor, Vivekananda Institute of Professional Studies-Technical Campus, Delhi
[5] Associate Professor, MAIT, Delhi
[*] Corresponding Author. Tel: 7217767115, E-mail: chirag.mait@gmail.com

Abstract: *It has always been challenging to collaborate when managing medical records, which leads to disjointed patient records and ineffective healthcare delivery. Promising against these challenges is the Solana blockchain, which is renowned for its abundant resources and inexpensive transaction fees. The project will start with a thorough analysis of PHR interaction as it stands today, emphasizing the shortcomings of the current setup and the need for fresh approaches. Subsequently, he will comprehend the attributes and functionalities of the Solana blockchain and emphasize its appropriateness for healthcare applications. Throughout the project's duration, a PHR management model on the Solana blockchain will be developed and created. Consensus management will be implemented via smart contracts, which will also make it possible for authorized stakeholders to share information transparently and safely.*

Keywords: Healthcare, PHR, Protocol, Solana Blockchain

1. INTRODUCTION

One of the key components that facilitates information availability in a healthcare network is the electronic health record (EHR) (Kumar et al., 2020). The process of digitizing patient health records for computer systems access by doctors, other healthcare providers, and patients is referred to as a "EHR" (Lee & Meuter, 2010). An EHR system will be very helpful to healthcare networks since it will reduce medical mistakes and enhance sickness management (Dean et al., 2009, pp. 611–638). Due to privacy concerns and insecure systems, patients are demotivated to share their health information in electronic health records (EHR) systems (Rezaeibagha et al., 2015; Zhang et al., 2022). Blockchain technology, for example, can create a secure system that better safeguards patients' privacy. Blockchain refers to distributed digital ledgers in information-sharing systems, each having its own database. It is vital to highlight that "user" refers to doctors, patients, and healthcare staff in the context of healthcare, particularly blockchain-based EHR system applications. Blockchain technology has sparked considerable interest in the healthcare industry as a potential means of upgrading existing systems.

The goal of the research is to fill gaps in electronic health record systems and make blockchain based solutions user-friendly and simpler to use in times of disaster. Patients' incapacity to manage personal health information, such as test findings and past therapies, influences their treatment options. EHR systems are vital today since they have shown to provide better medical diagnoses. However, because to their centralized and non-interoperable nature, existing EHR systems have proven unsuccessful. Also, patients' privacy and security concerns are causing them to refrain from actively sharing their health information because they are concerned about the security mechanisms in use.

Effective patient management is critical for several reasons:

- ✓ Continuity of patient care: This ensures that all healthcare providers have access to accurate and up-to-date information about a patient's medical history, treatment and test results, enabling continuity of care and informed decision-making.

- ✓ Patient safety: Properly managed patient records reduce the risk of errors such as medication mix-ups, duplicate tests or missed diagnoses, which improves patient safety.

- ✓ Efficiency and cost-effectiveness: Simplified record management processes save time and resources reducing the elimination of the need for manuals, reducing administrative burdens and avoiding unnecessary healthcare costs.

- ✓ Data analysis and research: Well-organized patient records are valuable data sources for analyzing health trends, improving research and clinical trials. results through evidence-based practices.

- ✓ Legal and Regulatory Compliance: Privacy laws and regulations such as HIPAA compliance are important to protect patient confidentiality and avoid legal liability for unauthorized use or disclosure of medical information.

However, despite its significance, efficient medical record management faces several challenges:

- ✓ Interoperability: Incompatibilities between different electronic health record (EHR) systems make it difficult to seamlessly exchange patient data between healthcare providers, leading to fragmented care and communication gaps.

- ✓ Security and privacy concerns: Protecting sensitive patient data from unauthorized cyber threats, access or violations is a constant challenge for healthcare organizations, especially with increased reliance on digital record systems.

- ✓ Workflow integration: Integrating EHR systems into clinical workflows without disrupting provider-patient communication or causing workflow inefficiencies requires careful planning and training.

- ✓ Data overload and information overload: The medical burden generated by electronic records the large volume of information can overwhelm healthcare providers, making it difficult to effectively obtain relevant information and make informed clinical decisions.

- ✓ Standardization and quality control: Differences in documentation practices and lack of information, standardization of medical terminology hinders data accuracy, quality control and data analysis.

A blockchain-based EHR system might provide consumers with autonomy over their health data while also offering cryptographic security via blockchain technology. On a blockchain, users might share their data with anybody, at any time, making it interoperable. Solana and other public blockchain protocols may make it simple for anybody to utilize the system. In the medical business, they use established threshold settings to examine patient data and perform real-time analysis to gather transaction metadata. So, smart contracts in the healthcare industry manage real-time analysis and transaction metadata tracking for medical sensors. Because of the architectural importance of the blockchain, clinical trial data management transparency could be improved using smart contracts. Also, smart contracts enable the creative and innovative automation of complex multi-step processes or time-consuming workflows. Moreover, blockchain protects data privacy and allows for secure data sharing (Xia et al., 2017b). Data entered by healthcare professionals into an electronic health record (EHR) is only available to medical specialists. Also, an EHR can only be accessed by one healthcare practitioner. However, individuals can use their electronic health records (ePHRs) to access health information from different sources, including patients and other healthcare professionals. Even though they have clear benefits, health consumers rarely use ePHRs.

Personal Health Record (PHR) systems, while offering benefits in terms of patient engagement and access to health information, still face several issues that impact healthcare delivery:

- ✓ Interoperability Issues: PHR systems often lack interoperability with the electronic health record (EHR) systems used by healthcare providers. This lack of integration leads to the fragmentation of health information and prevents the smooth exchange of information between patients and health care providers. As a result, incomplete or unavailable patient data can compromise healthcare.

- ✓ Security and privacy risks: PHR systems store sensitive health information, making them an attractive target for cyberattacks and data breaches. Inadequate security measures can compromise patient privacy and confidentiality

and undermine trust in the healthcare system. Breaches of PHR systems can lead to identity theft, medical fraud and other harmful outcomes for patients.

- ✓ Accuracy and Reliability of Patient Information: Patients are often responsible for updating and maintaining their PHR information, which can lead to inconsistencies and inaccuracies in the information. Inaccurate or incomplete information to health care providers can lead to misdiagnosis, inappropriate treatment, or medical errors that compromise patient safety and outcomes.

- ✓ Limited adoption and availability: Despite efforts to promote PHR adoption, many patients still do not actively do access or use these systems. Limited access to technology, barriers to digital literacy, and privacy and security concerns can hinder PHR adoption, especially among vulnerable populations. This limited adoption limits the potential benefit of PHRs in improving health care and patient outcomes.

- ✓ User experience varies. PHR systems can lack user-friendly interfaces and intuitive design, resulting in a disjointed patient experience. Confusing navigation, complex terminology and technical glitches can frustrate patients and prevent them from actively using their health information. A fragmented user experience prevents effective communication between patients and healthcare providers and makes collaborative care and shared decision-making difficult.

- ✓ Lack of standardization and integration: PHR systems often lack standardized formats and data structures, which leads to inconsistencies in data storage. health information. and is displayed. The lack of a standard makes it difficult to share and exchange information between different PHR systems and healthcare providers, which hinders interoperability and coordination of care.

Making blockchain-based solutions accessible to a bigger audience with various backgrounds is the most challenging problem. To address these concerns, the system will employ a custodial wallet architecture, eliminating the need for users to managing wallets and other assets. Furthermore, the system will pay all transaction costs for the user. In the future, these charges will be added to the hospital bill as convenience fees. Patients would just input their phone numbers, which would be validated by the ABHA ID.

With move from specialized facilities to community-based healthcare settings in the growing medical situation, it will serve as a medium for organized administration of users' health data. We developed a blockchain protocol to demonstrate the system's feasibility and superiority over traditional EHR systems. Our proof-of-concept gives control over health information as well as interoperability the ability to share medical records safely and freely with anyone. It is feasible to achieve five major goals by using our model: (1) Users have access to their medical records. (2) Users may quickly and securely share their medical records with anybody. (3) Users own personal health records, which are not held by a centralized institution such as a network of hospitals or laboratories. (4) Create an immutable system for tracking all user and medical record activity to protect stakeholders legally. (5) a decentralized blockchain-based system that everyone may use without needing to maintain blockchain assets.

2. BLOCKCHAIN FRAMEWORK

2.1 Introduction

Blockchain is a distributed, decentralized, and public ledger. It works with a distributed database. Several distributed, connected nodes are used to achieve decentralized data storage. They collaborate to administer the network and jointly control the blockchain network. These nodes collaborate to manage data using a unique approach that employs cryptographic algorithms to ensure security and availability. These nodes employ consensus mechanisms to validate and add a user's transaction to the ledger. Throughout this process, data is also stored in blockchain components called as accounts. The major advantage of distributed and decentralized networks is that data is available and tamper-proof to all network members. Cryptographic algorithms help to protect identity and trackability. Processes to ensure blockchain to work:

- ✓ **Data Replication:** All nodes have the same data, so data needs to be sent every node after each transaction. In this way, data is copied or consistent in network.

- ✓ **Data Duplication:** Every blockchain member has access to the whole ledger and the status of the blockchain. This also aids with transaction verification and node consensus utilizing their data. As a result, data is accessible and secure.

Blockchain components include:

- ✓ **Node:** single node in the network.
- ✓ **Transaction:** The event changes the state of blockchain
- ✓ **Block:** A single piece, like a ledger page, that has many transactions grouped together.
- ✓ **Hash:** A variable string of a fixed length made by cryptographic hashing method.

The Solana Blockchain is being used to construct this protocol. It is a relatively recent blockchain that allows you to trigger computer instructions (smart contract) in addition to sending money. It is an open, public, decentralized blockchain that allows anybody to design protocols, utilize the blockchain, and join the network. It employs the Proof of History consensus process, which aids in the formation of new blocks. Blocks are used to store transactions and relate to a hash. The current block is constantly connected to the preceding block hash, producing a chain of blocks known as a ledger. A hash function is used to create the hash from an arbitrary text and other needed inputs. Hashes are irreversible, which means that we cannot track an arbitrary text or inputs through a hash. Finding the input from output strings is impossible. Solana use the SHA256 hashing algorithm. All medical data, as well as a history of data access and data authority, is encrypted and maintained on blockchain.

Smart contracts are self-executing contracts with the terms of the agreement directly written into code. In the context of Personal Health Records (PHRs) or healthcare in general, smart contracts can offer various functionalities to enhance data management, patient care, and regulatory compliance. Here are some key smart contract functionalities in healthcare:

- ✓ Access Control: Smart contracts have the ability to regulate access to PHR data, making sure that only people with permission—such as healthcare professionals or approved family members—are able to read or alter particular data. Granular control over data access can be enforced through the encoding of access rights in the smart contract.
- ✓ Consent Management: Patients can designate which parties are allowed access to their health information and under what circumstances by using smart contracts, which can streamline consent management procedures. Through interactions with the smart contract, patients can alter or revoke their consent preferences, giving them control over data sharing and transparency.

Regarding compliance with healthcare regulations, smart contracts must adhere to relevant laws and standards to ensure the protection of patient data and compliance with privacy regulations such as HIPAA (Health Insurance Portability and Accountability Act) in the United States or GDPR (General Data Protection Regulation) in the European Union.

- ✓ HIPAA Compliance: HIPAA laws, which include strict standards for data security, privacy, and confidentiality, must be complied with by smart contracts handling PHR data. To protect patient data and stop illegal access or disclosure, smart contract developers must put strong security measures in place, such as encryption, access controls, and audit trails.

- ✓ GDPR Compliance: In order to function in regions where the GDPR is applicable, smart contracts must abide by its tenets, which include the rightful handling of personal data, accountability, and data subject rights. In compliance with GDPR regulations, smart contracts should have procedures for gaining and handling user consent in addition to supporting requests for data portability, erasure, and rectification.

2.2 Why Solana?

Solana is a blockchain that is both scalable and quick. It can run programs to accomplish complicated transactions like Ethereum, but it has many greater capabilities that are appropriate for the PHR Protocol. Solana has an extremely scalable design and can manage a big number of transactions. As a result, it will be capable of handling transactions for a big population.

On a standard gigabit network, Solana may theoretically accomplish up to 710,000 TPS, which is exceptionally as compared to Ethereum's 30 TPS (Transactions Per Second). It replicates itself using Optimistic Concurrency Control without sacrificing transaction speed. Through the Solana design, transactions may be completed in parallel. Parallel processing of transactions and fast transaction speed are suitable for PHR, because of the huge population and rate of increase in patients.

Solana advantages for healthcare includes:

- ✓ High performance: Solana can process thousands of transactions per second, making it suitable for daily processing of large amounts of health data. This high performance ensures timely access to patient data and other critical data and improves the efficiency of healthcare.

- ✓ Low transaction costs: Solana's powerful consensus mechanism and low transaction fees make it cost-effective for health services. This affordability is especially important for healthcare organizations operating on tight budgets, as it lowers the financial barriers to adopting blockchain technology.

- ✓ Scalability: Solana's scalable architecture allows it to support growing numbers of users and applications without compromising performance. This scalability is important for the growing needs of the healthcare industry, such as the integration of mobile devices, telemedicine platforms and IoT devices.

- ✓ Security and Privacy: Solana's strong security features combined with privacy features make it suitable for storage and maintenance, sharing sensitive health data. Solana ensures the confidentiality and integrity of patient data using encryption technologies and authorized access rights, while complying with data protection regulations.

Some relevant use cases of Solana demonstrating its strengths include:

- ✓ Decentralized Finance (DeFi): Solana's high throughput and low latency make it well-suited for DeFi applications such as decentralized exchanges (DEXs), liquidity pools, lending protocols, and stablecoin issuance platforms. Projects like Serum, Raydium, and Mango Markets leverage Solana's capabilities to provide fast and cost-effective financial services.

- ✓ Non-Fungible Tokens (NFTs): Solana's scalability and fast confirmation times make it ideal for NFT marketplaces, digital art platforms, and gaming ecosystems. Projects like Solsea, Solible, and Solanart enable creators and collectors to mint, trade, and showcase NFTs on the Solana blockchain.

- ✓ Healthcare Data Management: Solana's high throughput and security features make it suitable for managing healthcare data, including electronic health records (EHRs), patient information, and medical research data. Solana's ability to handle large volumes of data efficiently and securely can improve data interoperability, patient privacy, and healthcare outcomes.

- ✓ Supply Chain Management: Solana's fast confirmation times and low transaction costs benefit supply chain applications, including product tracking, inventory management, and logistics optimization. Projects like Stardust, Mercurial, and Everlasting leverage Solana's capabilities to create transparent, efficient, and resilient supply chain solutions.

Solana generates a block in 400ms, indicating that it has an extremely short block duration. Solana's transaction processing is lightning quick. It employs the Proof of History approach, in which the node's leader generates a new cryptographic proof of blocks whenever some time has passed since the last proof. Because of the low block duration, transaction confirmation time in Solana will be extremely fast. Because medicine is such a delicate subject, and milliseconds can mean the difference between life and death, doctors must have quick access to medical information. As a result, it’s best blockchain for constructing our system.

2.3 Custodial Wallet Architecture

Custodial wallets are services that store and maintain users' private keys in a centralized manner. They are simple to use, recover, and access, making them user-friendly. Coinbase and Biance are two instances of custodial wallet software. We employ the custodial wallets design to make it easier for users of various backgrounds to manage the system's crypto assets and avoid the hurdles of joining the blockchain. It also aids in the administration of user identities. In the event of a medical emergency, the user may be unable to manage their own crypto wallet for transaction fees and account rent.

3. SYSTEM DESIGN

3.1 Identifying the Issue:

As Digital India and global digitization advance, more hospitals are developing and maintaining their own EHR systems. However, because these systems are incompatible, a hospital cannot access data from other hospitals' systems. Patients who wish to see a new doctor or a doctor from another hospital find it difficult to transfer their information as a result. Because the patient does not have the data, hospitals can destroy it at any moment, and the patient may lose vital health information. Another drawback with these systems is their lack of security. Because hospitals typically hold data on unprotected file systems, there is a risk of sensitive user data leaking. We developed the "Interoperability Personal Health Records Protocol" to address this issue. It is a global health stack identity and document management protocol. The user can save their own health records on a non-changeable file storage system and share them with other system users. The user has complete ownership over their health data on blockchain systems, which cannot be altered, and may share it with anybody, at any time. Because it is built on top of a Public Blockchain, Solana, and anybody with permission may view the health data, it eliminates the problem of not being able to work with other systems. Furthermore, the data is stored on a blockchain system that cannot be altered, ensuring that the user will never lose their data.

3.2 ABHA ID

14-digit ABHA ID would provide each participant in India's digital healthcare ecosystem with a distinct and trustworthy identification. This identification will be recognized by medical specialists across the country. With this number, you may easily join PHR (Personal Health Records) programs that share health data, such as the ABDM ABHA app. Avoid standing in large lines at medical institutions. Simple PHR Enrolment: Join PHR (Personal Health Records) programs that make it simple to share health information, such as the ABDM effort. In this project, each user will be assigned a unique Abha ID, used for authentication. ABHA provides OTP (one-time password) based verification that use the registered phones number of the users for verification.

3.3 Structure of Accounts:

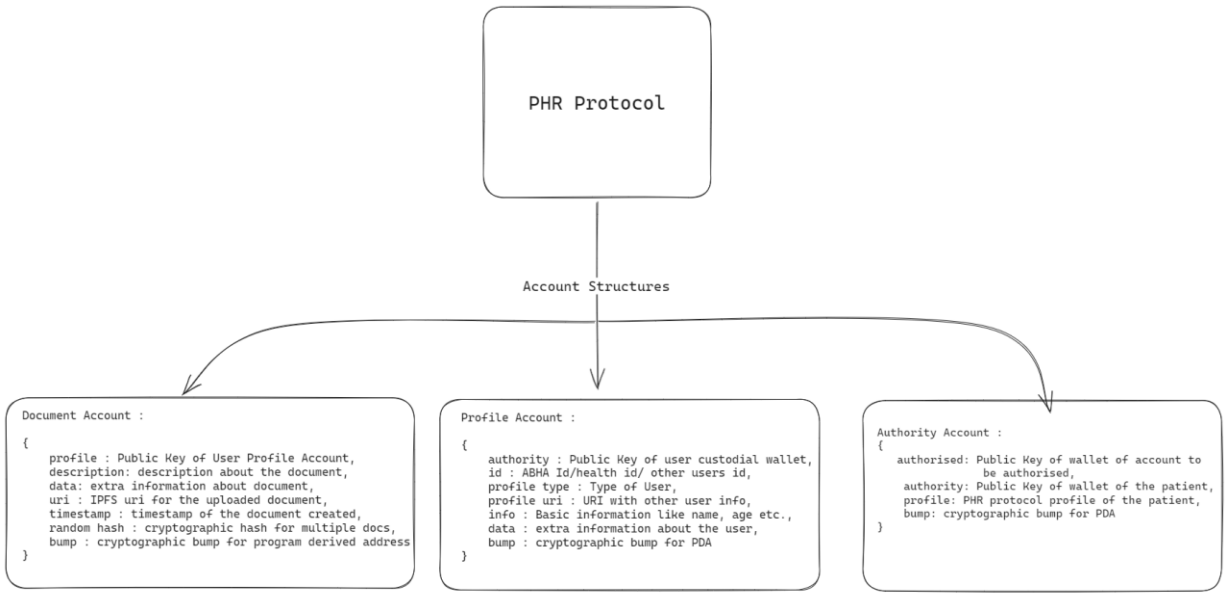

Figure 1: Various Account Structures

3.4 Information Flow:

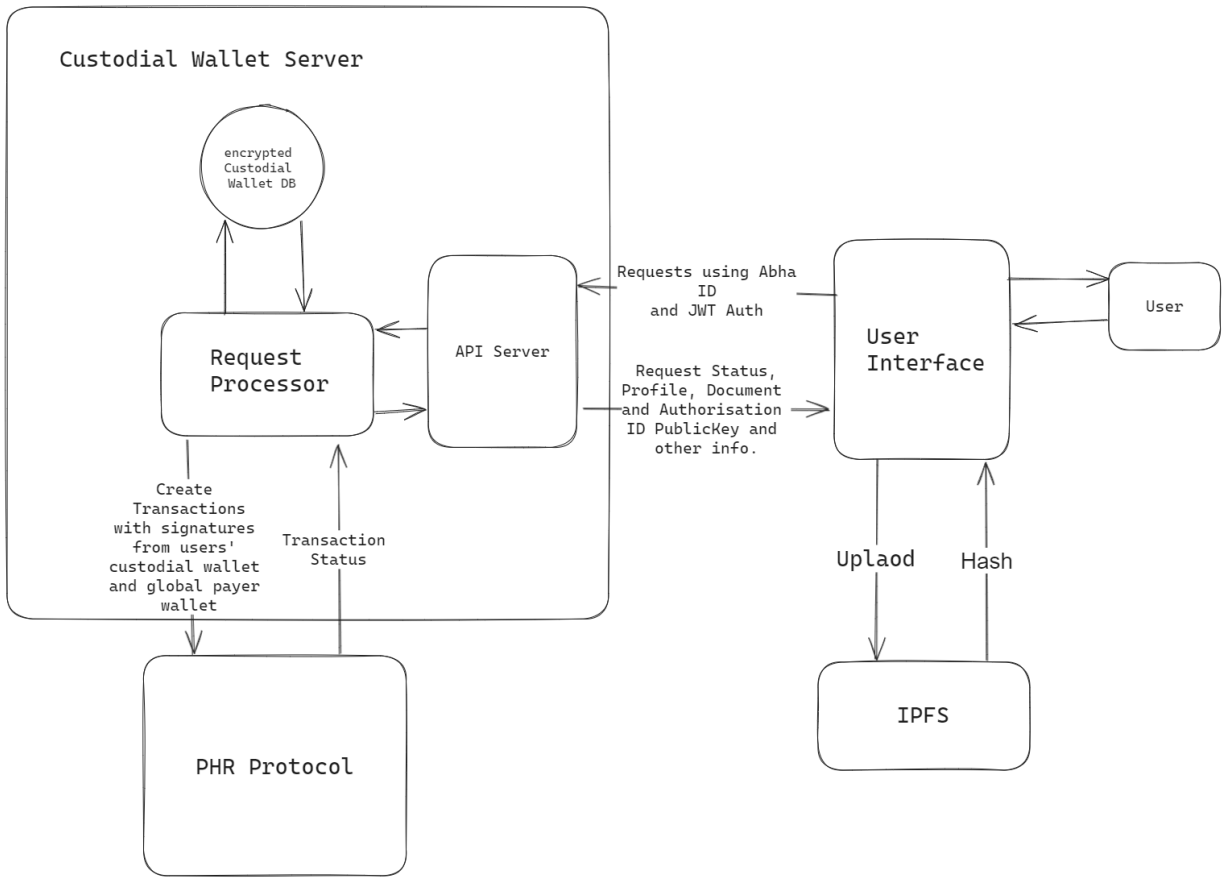

Figure 2: Data flow between components

4. RESULTS

Since organisations are intricate systems, gathering and applying environmental data is a major issue. An organization's main duty is to come to an agreement over the gathering, handling, and distribution of data. The company's blockchain platform drives research into alternative technologies for exchanging and debating medical data, as well as proof of concept studies. Consequently, the pre- and post-processing analysis focused on three key areas: 1) information sharing, 2) effectiveness, and 3) usability, accuracy, transparency, and traceability.

A. Research Examples:

The findings of the study offer different approaches to the integration of blockchain technology with personal health record (PHR) interaction. Many challenges, including those related to isolation, security, and rivalry, plague the PHR systems of today, according to a survey of the literature. Furthermore, this research establishes the groundwork for evaluating the efficacy of blockchain technology by disclosing different applications and solutions employed to address these issues.

Research on the application of blockchain in healthcare has yielded promising results, suggesting that it may be able to address PHR challenges. The impact- and shock-resistant characteristics of blockchain can enhance data security, facilitate simple information transfer, and grant patients independent access to their medical records. Agreements and information sharing may be managed with smart contracts in an effective and transparent manner.

B. Studying the impact of blockchain on PHR interactions: The research into the influence of blockchain on PHR interactions has been quite fruitful. The robust security characteristics of blockchain reduce the possibility of illegal data access and usage. By offering security and transparency, blockchain addresses data integrity issues that plague the PHR process. A thorough examination and evaluation of the influence of Blockchain on PHR interactions is possible. Blockchain enhances collaboration by offering safe and dependable data sharing. This not only enhances doctor-patient communication, but it also lowers mistakes and discrepancies in medical records. The fundamental advantage of blockchain technology is that it empowers patients. The present emphasis in healthcare on cooperation and self-management corresponds with the trend toward centralized patient data management. Even with these encouraging results, there are still obstacles to overcome. Blockchain adoption is hampered by its scalability, particularly when dealing with the massive amounts of data generated in the healthcare business. As the implementation process progresses, business integration is required to support the successful deployment of a blockchain strategy.

The primary advantage of blockchain technology is patient empowerment. The present focus in healthcare on collaboration and self-management aligns with the move towards centralised patient information management. Even with these positive results, there are still issues. Adoption of blockchain is hampered by its scalability, particularly when handling the massive volumes of data produced in the healthcare industry. Business integration is necessary as the implementation process progresses to guarantee the deployment of a blockchain strategy that works. The recommendations will be developed and communicated based on the clinical presentation of the patient. It is impossible to overlook information that is crucial to the patient's health because of this network. The whole medical history of a patient can be accessed through an EMR. As a result, statistical analysis of this data is possible. The accuracy and speed at which medical data is gathered, shared, and decisions are made can all be improved by digitization.

Patients will be made aware of the site's existence as well as any updates, integrations, or corrections, as well as its functionality, informational content, and purpose. the conditions that govern the transfer of information as well as how it is stored. Patients find it challenging to divulge their medical information. Sharing information from any location, including a pharmacy, radiology lab, or laboratory, is difficult for nurses, doctors, and other healthcare professionals. The platform for real-time patient health monitoring can forecast illnesses and enhance services. The definition of healthcare is the dissemination of clear, helpful information to the public, including high-quality data on health outcomes, efficacy, and user experience, with the goal of motivating medical professionals, nurses, patients, and others to attain better results. The foundation for processing personal data is trust. Giving patients information that is understandable, transparent, and clear is crucial. To help patients better understand English-language doctor's notes, our website provides pictures and health-related information. In addition, openness facilitates decision-making for patients and carers when selecting a treatment programme, facility, course of treatment, or alternative therapy. Also, it will strengthen the bond between patients and doctors and their trust during care.

Hospitals can improve health outcomes by using our medical information sharing strategy to help them make better decisions. Helping doctors with diagnosis, patient care, and treatment options are all part of the goal. You can reduce healthcare costs, predict and prevent infectious diseases, and enhance your general quality of life by interpreting patient data.

5. CONCLUSIONS

This study aims to investigate the potential applications of blockchain technology in integrated health records and how patient willingness to engage with EHR systems is impacted by these applications. In this study, patients were empowered by blockchain-based information technology, which also enhanced their willingness to share information, decreased medical expenses, and lessened pain. Ideas, as well as findings and experiments, have a theoretical foundation thanks to the architecture of private accounting. The results of this article's discussion of endogeneity and bias demonstrate how biased and consistent the model is.

Everyone's right to health is vital to their daily lives. Improvements in medical technology have made it possible for people to live better, longer lives. In the areas of equipment and medicine, some noteworthy advancements have been made. Another improvement that EHRs—digital records of patients' medical records—offer is medical records management. Medical histories, treatment schedules, allergy information, and other health-related data are all included in EHR data. Encouraging the simple sharing and application of medical information is crucial. Users of today demand constant, up-to-date information. In order to provide better care, ePHR enables EMRs to store patient data and share it with other departments or hospitals. Electronic health records, medical software, and health management data are all being actively used by numerous healthcare organisations. Due to the fact that EHRs frequently contain medical data, they can be challenging for physicians to use. Furthermore, EMR supports every patient's medical requirement; it could be helpful to them. Our network enables end users to search for employment, select a course of treatment, and obtain healthcare information. It may also send messages promoting continuity or cooperation amongst providers. In order to facilitate EHR integration, we offer a blockchain network.

Many businesses have acquired or are acquiring the technology required to satisfy users' immediate information needs. Sadly, the course of treatment is postponed. A suggested solution for EHR integration is blockchain-based. The electronic core with one of the ineffective functions is supposed to be removed. Information technology transmission ensures the security of the system since no user can alter this list. In nursing, traditional education is hard, sluggish, occasionally demanding, and has little bearing on practise. Legacy systems' skewed health data makes it challenging to share because of inconsistent standards and conventions. To put it plainly, the current medical information system is disjointed and inadequate for the demands of modern patients. All patient data, including critical personal data like allergies, immunisations, prior hospital stays and abortions, mental health conditions, and torture, is fully available in electronic medical records (EMRs). from digital health records. Our policies are made to guarantee that medical information is accurate and private. While this method shows promise in safeguarding patient privacy, more privacy testing and protection are required. Medical records are used by many healthcare providers to monitor their systems; they frequently do not share this information with other organisations. As a result, numerous hospitals will receive the patient's medical data. According to this concept, doctors will receive assistance in completing the patient's electronic health record (EHR) from the time of initial contact. The hospital stores the patient's medical records and updates them regularly, which is a benefit of this approach for physicians. Patients should be able to examine their medical records thanks to a collaborative, adaptable, and robust approach.

Adding, removing, or changing inaccurate information in already-existing medical records could put doctors in danger of legal repercussions. Recovery evidence needs to be provided and finished on time. Failure will ensue if this isn't done. Patient medical records are published by numerous clinics, hospitals, networks, and nations. Patients' interactions with one another result in a great deal of contradictory information about the same patient being kept in various institutions. This information includes medical records and health data like blood test results. The duration of treatment is reduced, and patients do not need to see a doctor. You can get answers to a lot of significant questions over the phone. Nonetheless, by facilitating more efficient communication, blockchain has the potential to enhance the telemedicine patient experience for the benefit of medical professionals, patients, and society at large.

The design, deployment, and viability of a blockchain-based electronic health record system that establishes a private, permissioned blockchain network for the exchange and storage of medical records between practitioners are covered in this article. As a result, the issues with medical services brought about by the sharing of patient data between hospitals are eliminated by the blockchain network. The practise of tamper-proof electronic data management is supported by our findings. As a result, the strategic plan enables businesses to use blockchain technology by removing transactional interactions, simplifying processes, and improving overall effectiveness and efficiency. Support services have created a wide range of career options. One potential avenue for the future is the use of artificial intelligence to generate dynamic smart contracts that address diversity. It is obvious that applying blockchain technology to healthcare research can have several advantages, including tracking, sharing, and transparency as well as lowering patient privacy concerns. To address this issue, future work will also need to build network and incorporate into cloud architectures.

In summary, effective medical record administration guarantees correct information retrieval, continuity of care, clinical decision support, quality improvement, patient participation, and legal protection—all of which considerably improve patient care and healthcare delivery outcomes. Nonetheless, problems with process integration, data security, overloading with information, interoperability, and lack of standardisation continue to exist. Subsequent investigations may concentrate

on tackling these obstacles through the creation of systems that are compatible, the augmentation of data security protocols, the optimisation of workflows, the advocacy of uniform documentation procedures, and the refinement of user interfaces. Investigating the possibilities of cutting-edge technology in healthcare record administration, such as blockchain and artificial intelligence, may also present creative ways to get around present problems.

Enhancements in user experience, interoperability, and data standardisation may result in a smoother transfer of medical records between healthcare systems, promoting better care coordination and better patient outcomes. Furthermore, upholding patient confidence and adhering to healthcare laws requires ongoing efforts to improve data security and privacy measures. All things considered, there is hope that future advancements in medical record management research and innovation will further improve patient care and healthcare delivery.

6. REFERENCES

[1] Dong, Y., Mun, S. K., & Wang, Y. (2023). A blockchain-enabled sharing platform for personal health records. *Heliyon*, *9*(7).

[2] George, M., & Chacko, A. M. (2023). Health Passport: A blockchain-based PHR-integrated self-sovereign identity system. Frontiers in Blockchain, 6, 1075083.

[3] Bisht, A., Das, A. K., Niyato, D., & Park, Y. (2023). Efficient Personal-Health-Records Sharing in Internet of Medical Things Using Searchable Symmetric Encryption, Blockchain and IPFS. IEEE Open Journal of the Communications Society.

[4] Yakovenko, A. (2018). Solana: A new architecture for a high performance blockchain v0. 8.13. Whitepaper.

[5] Pierro, G. A., & Tonelli, R. (2022, March). Can Solana be the solution to the blockchain scalability problem? In 2022 IEEE International Conference on Software Analysis, Evolution and Reengineering (SANER) (pp. 1219-1226). IEEE.

[6] Hajian Berenjestanaki, M., Barzegar, H. R., El Ioini, N., & Pahl, C. (2023, July). An Investigation of Scalability for Blockchain-Based E-Voting Applications. In International Congress on Blockchain and Applications (pp. 134-143). Cham: Springer Nature Switzerland.

[7] Chalkias, K., Chatzigiannis, P., & Ji, Y. (2022). Broken Proofs of Solvency in Blockchain Custodial Wallets and Exchanges. Cryptology ePrint Archive.

[8] Nair, V., & Song, D. (2023). Decentralizing Custodial Wallets with MFKDF. arXiv preprint arXiv:2306.08168.

[9] Barbereau, T., & Bodó, B. (2023). Beyond financial regulation of crypto-asset wallet software: In search of secondary liability. Computer Law & Security Review, 49, 105829.

[10] Namasudra, S., & Deka, G. C. (Eds.). (2021). Applications of blockchain in healthcare. Singapore: Springer.

[11] Yaqoob, I., Salah, K., Jayaraman, R., & Al-Hammadi, Y. (2021). Blockchain for healthcare data management: opportunities, challenges, and future recommendations. Neural Computing and Applications, 1-16.

[12] Saranya, R., & Murugan, A. (2023). A systematic review of enabling blockchain in healthcare system: Analysis, current status, challenges and future direction. Materials Today: Proceedings, 80, 3010-3015.

[13] E. R. D. Villarreal, J. García-Alonso, E. Moguel and J. A. H. Alegría (2023). Blockchain for Healthcare Management Systems: A Survey on Interoperability and Security.