E-MEDICAL RECORD SYSTEM USING BLOCKCHAIN TECHNOLOGY

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Abstract- **The "E-medical Record System Using Blockchain" intends to transform healthcare data management by leveraging blockchain technology's security and transparency. This system provides a decentralized platform for securely storing, retrieving, and managing electronic health records (EHRs). Using blockchain capabilities, the system provides data integrity, immutability, and accessibility while protecting patient privacy and confidentiality. Healthcare providers can safely share patient information across institutions and healthcare networks using blockchain technology without compromising data security. Each medical record is encrypted and saved as a blockchain transaction, guaranteeing that only authorized individuals with the proper encryption keys have access to the data. Furthermore, blockchain's decentralized structure eliminates the need for intermediaries, lowering administrative costs and expediting the medical record maintenance process. Patients also get more control over their health data since they can give or remove access permissions for healthcare providers as needed. This novel method to medical record administration has the potential to improve patient care, increase data interoperability, and save healthcare costs.**

Keywords: **IPFS, Blockchain, Smart contracts, HER.**

I. INTRODUCTION

Electronic Health Records (EHR) using blockchain technology provide a cutting-edge option for improving data integrity, security, and interoperability in the healthcare industry. Blockchain's decentralized and immutable nature allows for tamper-proof storage and transparent access to patient records across many healthcare providers. Implementing blockchain in EHR systems can help to prevent data breaches, privacy problems, and data fragmentation, resulting in seamless medical information sharing and giving patients more control over their health data. This revolutionary strategy not only transforms existing EHR systems, but it also paves the path for better healthcare delivery, patient outcomes, and management. The impetus behind this project's development is to tackle important issues facing the healthcare industry, including those related to electronic health records (EHR). Traditional EHR systems have problems with interoperability, data security, and privacy violations. By offering a safe, open, and decentralized platform, the incorporation of blockchain technology seeks to completely transform the management of medical records. The goals of this
initiative are to improve patient privacy, guarantee data integrity, and expedite provider collaboration. The project aims to construct an effective, patient-centered EHR system that mitigates current issues and establishes a new benchmark for the secure transmission of medical data by utilizing blockchain's tamper-resistant features and smart contracts. Patients' access to and control over their own medical data is restricted by the fact that healthcare organizations frequently control the conventional Electronic Health Record (EHR) systems. It is difficult to access and share medical records when there is a lack of patient empowerment, data security, and interoperability amongst medical providers. A safe, patient-centered EHR system that uses blockchain technology to guarantee data privacy, security, and effective data interchange while granting patients more control over their health information is required to address these problems.

II. RELATED WORKS

The electronic health record (EHR) system using blockchain technology, as described by the author in [1], promises improved security, transparency, and patient empowerment. It is a novel method to managing healthcare data. Sensitive medical data contained in the EHR is secure thanks to the decentralized and immutable ledger of blockchain technology. This data is safeguarded by SHA-256 encryption, which is widely recognized for its strength in preserving data integrity. The application's user-friendly design facilitates easy interaction with the EHR system by guaranteeing accessibility for both patients and healthcare practitioners. Users may easily access and manage their medical records because to the design's intuitive layout and clear navigation, which encourages more accountability and participation throughout the patient experience. Additionally, the system's affordability makes it a desirable

option for healthcare organizations looking for effective data management solutions. Blockchain technology lowers the operational expenses associated with traditional EHR systems by doing away with middlemen and simplifying procedures, which eventually helps patients and providers. The control patients have over their health data is one of the main benefits of this blockchain-based EHR solution. Patients who own full ownership and control over their electronic health records (EHRs) can safely exchange pertinent data with medical professionals, enabling better informed choices and individualized treatment. Furthermore, patients and healthcare practitioners might have more trust because of the transparency that blockchain technology offers.
A significant move toward patient-centric interoperability in healthcare is examined by the author in [2] blockchain technology for healthcare: Facilitating the Transition to Patient-Driven Interoperability. The authors propose enhanced data security, integrity, interoperability, transparency, and accountability through the utilization of blockchain technology. Amidst a period characterized by increasing volumes of healthcare data, blockchain presents itself as a revolutionary remedy, providing a decentralized and unchangeable record to protect confidential medical data. Additionally, the design of blockchain gives patients unprecedented control over their data, allowing for seamless sharing while maintaining anonymity. The authors address the difficulties brought about by the intricacy of managing healthcare data, highlighting how blockchain technology might improve cooperation within the healthcare ecosystem and streamline procedures. In the end, this paradigm change toward patient-driven interoperability signals the beginning of a new chapter in the history of healthcare delivery, one in which patients are empowered, data security is strengthened, and creative uses of blockchain technology lead to better outcomes.

The author explores important data quality issues inside Electronic Health Records (EHR) in [3] Electronic Health Records in Research: Quality Issues, Essential Thresholds, and Remedial Actions. It pinpoints four main problems: aggregation/augmentation, missing data, inconsistent coding schemes, and non-standard coding schemes. The essay provides in-depth insights into the difficulties associated with preserving the quality of EHR data by concentrating just on these elements. It also looks at how Blockchain might be used to solve these problems, offering solutions to improve data quality without getting into more serious blockchain problems. The article lays the foundation for better healthcare data management practices by offering a strategy for reducing quality issues in EHR systems through careful analysis and focused corrective measures.

The author provides a thorough analysis of how blockchain technology can transform the exchange and archiving of patient electronic health records (EHRs) in [4] electronic health records on a blockchain. The study offers significant insights into the secure sharing of sensitive medical information in the healthcare sector because it only focuses on EHRs in a blockchain environment. The review carefully examines the literature to determine the main problems, difficulties, and possible advantages of using blockchain technology into EHR systems. It illuminates how blockchain technology can revolutionize data security, privacy, and interoperability in healthcare environments. Additionally, the research delves into cutting-edge blockchain-enabled information exchange systems that present fresh answers to persistent problems with healthcare data management.

The crucial sensitivity of solar cell surfaces to flaws that affect efficiency is addressed by the author in [5] by putting forth an effective visual inspection technique based on modified morphological and edge detection algorithms. The technique extracts and highlights objects on a solar cell surface by combining numerous applications of morphological and Canny edge detection with customized settings. Following detection, the objects are classified so that various defect kinds and components can be identified using characteristics and a classification algorithm. The experimental results validate the effectiveness of the suggested method, demonstrating its potential to satisfy real-time processing needs and providing promising results in comparison with the state-of-the-art methods.

In [6], the author provides a thorough analysis of the literature on nurses' attitudes toward and use of electronic health records (EHRs). The evaluation provides light on the difficulties nurses have while integrating EHRs into their routine practice and adjusting to them through careful examination. It draws attention to how EHRs are seen as obstacles to information contextualization, teamwork, and patient care planning, which affects nurses' cognitive work processes. The study indicates that even with the incorporation of electronic reports and handoff tools, nurses' workflow is not adequately supported by these systems, causing them to rely on self-created paper forms for effective information management throughout shifts and handoffs. This dependence on manual techniques highlights how inadequate the present EHR systems are to satisfy the changing demands of nursing practice. The review also emphasizes how crucial it is to provide EHR features and interfaces that complement nurses' cognitive workflows and improve their capacity to deliver safe and efficient care.

III. METHODOLOGY

The architecture of Med-Chain, an e-medical record system enabled by blockchain technology, is depicted in Fig. 1. It uses a client-server architecture with a decentralized blockchain-powered backend. This novel method divides functions into discrete layers to provide scalability, security, and maintainability while addressing important issues in healthcare data management. The design document for the system outlines its architecture, parts, and functions with an emphasis on dependability, security, and scalability. The user interface (UI) consists of a front-end that is available to patients, healthcare providers, and administrators through the Med-Chain application. It makes it easier to register patients, see medical records, and regulate access while guaranteeing safe record generation, changes, and access for healthcare professionals. For a smooth user experience, the UI places a high priority on user-friendly interaction and straightforward navigation. Essential database administration and business logic are housed in backend services, which also handle external communication, authentication, and data processing. In order to preserve data integrity, strong authentication procedures are used for role-based access control, guaranteeing safe storage and retrieval of encrypted medical records. The blockchain infrastructure uses smart contracts for automation and access control, and it stores encrypted medical records on the Ethereum blockchain. All medical records are hashed, encrypted, and kept on the blockchain to guarantee accountability, transparency, tamper resistance, and immutability. IPFS integration adds decentralized and secure data storage capabilities to the blockchain architecture. It further improves the resilience and dependability of the system by facilitating the quick retrieval and sharing of encrypted medical records using content-based addressing with distinct hashes for data availability.

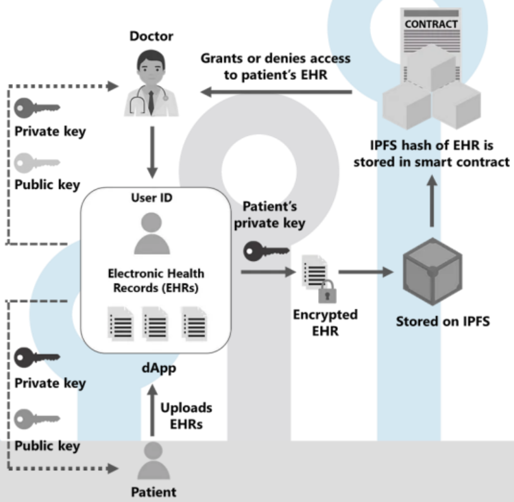

Fig. 1. Architectural Diagram for the Proposed System

The graphic illustrates a system that uses IPFS and blockchain to manage electronic health records (EHRs) at four different stages. First, patients use a decentralized application (dApp) to easily upload their EHRs to the system during the "Uploading EHRs" step. By providing a user-friendly platform, this intermediate interface makes it easier for patients to communicate with the blockchain network. Additionally, the patient's public key is used to encrypt EHRs, guaranteeing data confidentiality and protecting patient privacy by limiting access to the information to only authorized persons who possess the matching private key. At the "Storing EHRs" stage, encrypted EHRs are stored on a distributed file storage system such as the Interplanetary File System (IPFS), which is a decentralized location. The peer-to-peer network architecture of IPFS makes sure that EHRs are dispersed over several nodes worldwide, improving data redundancy and security. Furthermore, a smart contract on the blockchain contains a hash of the EHRs. By acting as a distinct identifier, this hash permits verification and guarantees the integrity of the data.

Stage 1: Uploading EHRs: During this first phase, the patient uploads their electronic health records (EHRs) using a decentralized application (dApp). The dApp acts as an intuitive user interface that makes it easier to securely move private medical data across the blockchain network. The patient's public key, a special code linked to their digital identity, is used to encrypt the EHRs during the uploading procedure. The medical information is kept private and shielded from unwanted access during transmission and storage thanks to this encryption technique. The dApp makes sure that only authorized parties with the matching private key may decode and access the uploaded EHRs by encrypting them using the patient's public key. By protecting the privacy and security of patient medical histories and treatment information, this cryptographic method improves data security.

Stage 2: Storing EHRs: The encrypted EHRs are then safely uploaded to a distributed file storage system, like IPFS (Interplanetary File System), via a secure protocol. IPFS uses a network of linked nodes to provide redundancy and fault tolerance, providing a decentralized and robust platform for data archiving and retrieval. By distributing the encrypted EHRs among several IPFS nodes, the danger of data loss or manipulation is decreased, and accessibility and availability are improved. In addition, a smart contract on the blockchain stores a hash of the encrypted EHRs. This hash allows for easy verification and retrieval of the encrypted data saved on IPFS by acting as a unique identification and reference point. The technology guarantees the integrity and transparency of the transaction by storing the EHR hash on the blockchain, giving the patient's uploaded medical data an unchangeable record. This hybrid method, which combines blockchain technology with IPFS, gives the system a strong, decentralized framework for safely storing and administering EHRs.

Stage 3: Accessing EHRs: A physician or other authorized healthcare practitioner uses the decentralized application (dApp) to submit a request for access to a patient's electronic health records. This request starts a verification procedure in which the authorization status and the doctor's credentials are checked against pre-established standards in the system. Following authentication, the request moves on to the following phase, which is the patient's response.

Stage 4: Granting Access: During this crucial phase, the doctor's access request is issued to the patient via the dApp interface. The option to grant or restrict access is entirely within the patient's power, and they can base their decision on personal preferences and privacy concerns. The patient gives the doctor permission to access and recover their IPFS-stored electronic health records (EHRs) if they so choose. The physician uses the patient's public key to decrypt the IPFS-stored electronic health records (EHRs) after getting permission from the patient. In order to ensure the integrity and authenticity of the retrieved data, this decryption method depends on the distinct hash of the EHRs stored on the blockchain inside a smart contract. The clinician can temporarily access the patient's medical records and study pertinent data for diagnosis, treatment, or consultation by using the patient's public key to decrypt the EHRs. The solution stresses patient autonomy and data protection while enabling secure and efficient access to EHRs by authorized healthcare professionals through this transparent and consent-driven method.

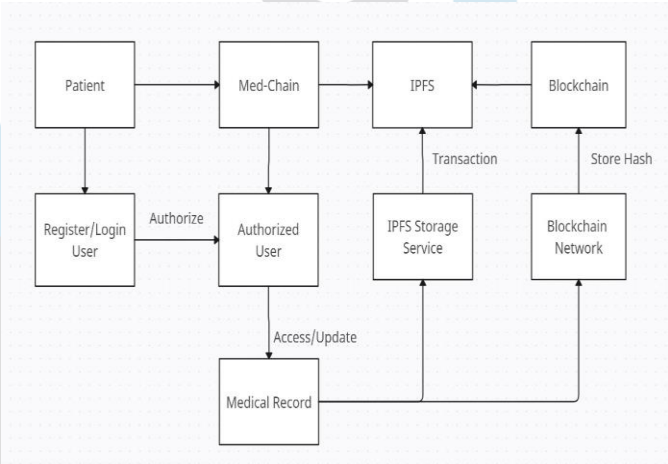

Fig. 2. Dataflow Diagram for the Proposed System

There are four main steps in the process of maintaining electronic health records (EHRs) in this system. Patients use a decentralized application (dApp) to safely upload their medical records to the system during the first upload phase of EHRs. This entails encrypting EHRs with the patient's public key, a cryptographic technique that protects privacy while data is being transmitted. The encrypted EHRs then reside on a distributed file storage system such as the Interplanetary File System (IPFS) throughout the storing phase. This decentralized storage technology improves data access efficiency while simultaneously enhancing robustness. A smart contract also stores a hash of the EHRs on the blockchain, offering a safe and unchangeable point of reference for verification. A doctor initiates a request at the accessing stage when they need to access a patient's electronic health records. In order to maintain control over who can access their medical records, the patient is prompted to examine and reply to the access request via the dApp interface. In the event that access is authorized, the physician uses the patient's public key to decrypt the IPFS-stored electronic health records, utilizing the IPFS hash contained in the smart contract to guarantee integrity and authenticity. This solution gives patients' autonomy and data protection first priority by utilizing blockchain and IPFS technology. While encryption techniques guarantee that only authorized personnel can access critical medical data, decentralized storage lowers the danger of data breaches. Furthermore, auditability is made possible by the blockchain's immutability, which offers a visible record of EHR transactions. Notwithstanding its ease of use, the system tackles important issues in healthcare data management, opening the door for safer and more patient-centered EHR designs.

IV. RESULTS AND DISCUSSIONS

The performance indicators of Med-Chain provide a strong basis for confidence in the efficiency and stability of the system. A system that is clearly capable of dependable data retrieval, transaction processing, and secure medical record storage has been produced by extensive testing and optimization. These accomplishments are supported by the thoughtful integration of IPFS and the Ethereum blockchain, which guarantees scalability and robustness while successfully addressing frequent issues with conventional, centralized EMR systems. Med-Chain's operational integrity and responsiveness are further validated by real-world simulations and user input, underscoring the technology's potential to completely transform healthcare data management. Improving data security and integrity in healthcare settings is one of Med-Chain's main goals.

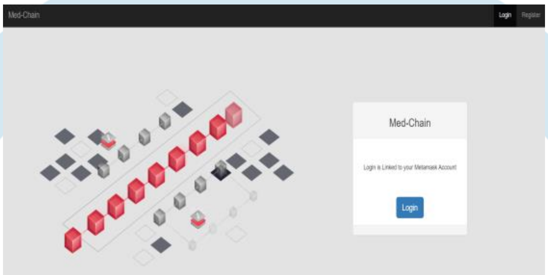

Fig. 3. Login Page

Users of the Med-Chain application are provided with a safe and easy way to access their medical records via the login page. The page makes use of the powerful features of MetaMask, a well-known cryptocurrency wallet and browser plugin that also functions as an identity management tool. It has a MetaMask login option. Med-Chain guarantees a high degree of security and gives users control over their account access by incorporating MetaMask authentication. When prompted, users enter the credentials for their MetaMask account, which usually consist of a password and a special cryptographic key pair. By establishing a secure link between the user's MetaMask wallet and the Med-Chain application, this authentication process allows access to the user's medical records while also confirming their identity. Strong encryption methods, decentralized identity management, and easy connection with blockchain-based apps like Med-Chain are just a few benefits of MetaMask's authentication mechanism. By using MetaMask for user authentication, Med-Chain improves the platform's overall security posture and gives users a dependable and comfortable login experience. Furthermore, Med-Chain's dedication to use cutting-edge technology to protect user privacy and data integrity is further demonstrated by MetaMask's login option. The goal of Med-Chain, which is to offer a safe and user-friendly platform for maintaining electronic health records and gaining access to healthcare services, is in line with the integration of MetaMask. The Med-Chain application's login page, which offers a MetaMask login option, exemplifies a progressive method of user identification in the healthcare industry. By utilizing MetaMask's capabilities, Med-Chain sets a high bar for privacy and data protection in the context of digital healthcare while ensuring strong security measures and providing users with a dependable and easy login experience.

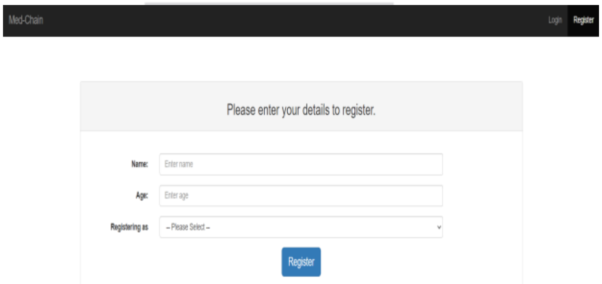

Fig. 4. Registration Page

The first place users can access the services of Med-Chain, an innovative healthcare application, is through its registration page. The page, which was created with efficiency and simplicity in mind, asks users to fill in the necessary information to register. To facilitate a fast registration procedure, three key fields are presented: name, age, and registration category selection. To ensure proper identification within the system, users are first asked to give their entire name in the "Name" area. This data is an essential part of creating user profiles and enabling individualized interactions within the program. Med-Chain hopes to build a user-friendly experience that encourages engagement and trust by collecting users' names. Users are then asked to choose a registration category from a list that has already been established. By selecting a category, a user can make sure that their position or status—such as "Patient," "Healthcare Provider," or "Administrator"—is represented in the system. Med-Chain may maximize efficiency and relevance by categorizing users into different groups and then customizing the user experience and functionality based on each group's unique requirements and permissions. Med-Chain's signup page prioritizes simplicity, clarity, and functionality, emphasizing user-centric design concepts. The application creates the foundation for effective and individualized healthcare interactions by gathering necessary data including name, age, and registration category. Med-Chain seeks to expedite the registration process by using an intuitive design and unambiguous prompts, therefore encouraging user engagement and pleasure right away.

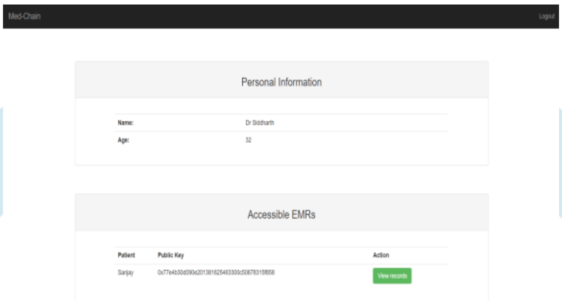

Fig. 5. Doctor Page

Healthcare workers may quickly access and manage patient medical records from a central location using the Med-Chain application's Doctor page. The doctor's details, including their name, are prominently displayed at the top of the page to guarantee easy recognition and create a customized user experience. This essential component promotes familiarity and trust between physicians and the Med-Chain platform. Physicians have easy access to and control over patient health information with a section dedicated to managing and obtaining medical records. Doctors can quickly search for specific patients in this section, examine thorough medical histories, and revise treatment regimens as necessary. The interface's user-friendly design makes it easier to get and manage data effectively, enabling physicians to provide the best possible care for their patients. The Doctor page might have features for communicating with patients, like messaging, appointment booking, and sharing health-related materials, in addition to accessing medical records. In addition, the Doctor page might include sophisticated analytics and tools like outcome analysis, risk assessment, and predictive modeling to aid in clinical decision-making. Physicians can maximize patient outcomes and make well-informed treatment decisions by utilizing data-driven insights. All things considered, the Med-Chain application's Doctor page offers a thorough and user-friendly platform designed with medical professionals' needs in mind.

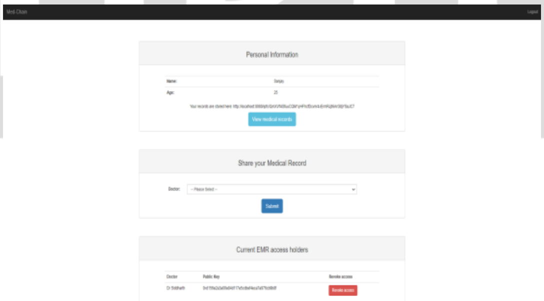

Fig 6. Patient Page

Patients may quickly access and manage their health information from one central location with the Med-Chain application's Patient page. The patient's details are clearly displayed at the top of the page, including their name and age, to facilitate easy identification and create a customized user experience. This fundamental component increases user engagement by fostering familiarity and trust between patients and the Med-Chain platform. The patient's whole medical record can be accessed and reviewed in a special section. Patients can easily browse through all of their medical history—including diagnoses, treatments, prescriptions, and test results—in this section. With the help of the user-friendly interface, patients may monitor their health and progress over time, giving them the ability to actively participate in their healthcare process. The Patient page has a component for controlling access to electronic medical records (EMRs) in addition to allowing users to view their medical records. Patients maintain control over the privacy and confidentiality of their health information by having the freedom to grant or revoke access rights to caregivers or healthcare professionals. In addition, the Patient page might have features for making appointment requests, asking for prescription refills, and corresponding via encrypted messaging with medical professionals. In the end, these interactive elements improve the continuity and quality of care by facilitating easy communication and collaboration between patients and medical personnel.

V. CONCLUSION

The fundamental advantages of Med-Chain, such as increased patient control, data security and privacy, openness, scalability, and cooperation, promise to completely transform the way healthcare data is handled and maintained. Med-Chain demonstrates operational integrity, user-friendliness, and the capacity to handle significant issues in healthcare data management through real-world simulations, performance testing, and user feedback. Success throughout the development and implementation phases of the project has confirmed Med-Chain's revolutionary potential in the healthcare industry and established it as a cutting-edge solution ready to revolutionize data management procedures. Future development for Med-Chain will focus on important features including interoperability, scalability, regulatory compliance, security improvements, and artificial intelligence integration.

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