Blockchain based Smart Healthcare Management System: Literature Review

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***Abstract*—This document presents summaries of research papers and UML diagrams focusing on the integration of Blockchain technology with healthcare systems and the Internet of Things (IoT). The use of blockchain technology for safe medical data management and storage, IoT and machine learning combined with blockchain technology for anomaly detection and forecasting in patient care, and the possible advantages and difficulties of integrating these technologies in the healthcare industry are all covered in these papers. The use of Blockchain and IoT solutions to improve data security, privacy, and efficiency in healthcare services is one of the major conclusions. The articles also emphasize how crucial it is to address concerns like network security, data privacy, and the necessity of workable implementation plans in order to fully utilize these technologies in healthcare settings.**

I. Introduction

First of all, the healthcare industry is undergoing a transformation thanks to digitalization and smart technologies, which are also enhancing patient care, optimizing the use of available resources, and fortifying healthcare administration systems overall. In this sense, revolutionizing the delivery and management of healthcare services requires the creation and implementation of a Smart Healthcare Management System (SHMS). Modern technologies like blockchain, Internet of Things (IoT), artificial intelligence (AI), and data analytics can be integrated with SHMS to offer a holistic solution for customized treatment plans, efficient patient monitoring, and optimized healthcare operations. This design-based study article aims to investigate the development and implementation of a state-of-the-art Smart Healthcare Management System to answer the evolving needs of patients, healthcare professionals, and other stakeholders in the healthcare ecosystem. The purpose of this study is to investigate the architecture, functions, design principles, and potential benefits of SHMS with regard to enhancing patient outcomes, distributing resources wisely, and enhancing healthcare delivery.

Using a design-driven methodology, this project attempts to address significant challenges in healthcare administration, such as data security, interoperability, real-time monitoring, and customized care delivery. By leveraging cutting-edge technologies and design principles, the proposed SHMS seeks to revolutionize healthcare procedures, give medical professionals access to relevant data, and empower patients to actively engage in their treatment process. This study article's overarching objective is to contribute to the growing corpus of knowledge on smart healthcare systems and provide informative guidance on the development, implementation, and design of SHMS for the future of healthcare administration and delivery.

II. Literature Review

In the ever-changing world of healthcare administration, blockchain integration is a game-changer that promises greater security, transparency and efficiency.

This innovative use case for blockchain in smart health management systems has attracted the attention of researchers around the world. After careful research and analysis of several research papers, the purpose of this introduction is to summarise the key findings and innovations that highlight blockchain's potential to revolutionize healthcare data governance and ensure the highest quality of patient care.

The paper, titled "Blockchain in Healthcare: A Novel Approach for Efficient Surgery Information Management Using Bitcoin Payments[1]" by Tran Le Nguyen, introduces a groundbreaking application of blockchain technology in

healthcare. Focused on surgery-related information management, the visual model for a medical app incorporates Bitcoin for payments, streamlining financial transactions in the healthcare ecosystem. Despite robust methodologies, implementation challenges arise due to high requirements. The study emphasizes potential benefits for patients and doctors and stresses the importance of addressing technical, regulatory, and practical aspects during implementation. Overall, the research underscores the transformative potential of blockchain in healthcare, calling for further development and refinement.

So starting with their paper titled ”Blockchain for the Internet of Things: A Systematic Literature Review” [1] authors Marco Conoscenti, Antonio Vetro, and Juan Carlos De Martin delve into the integration of blockchain and Peer-to-Peer technology within the realm of the Internet of Things (IoT). The study meticulously examines 18 blockchain use cases, with a specific emphasis on four applications tailored for IoT and private data management. Notable challenges such as integrity and adaptability are identified, where privacy is constrained to pseudonymity and adaptability is contingent on Proof-of-Work difficulty. Categorizing existing blockchain applications, the research provides insightful recommendations to address these challenges in future endeavors. The authors express their intent to explore secure and scalable blockchains, formulate a structured system for IoT applications, and enhance privacy through protocols mixing and other innovative approaches in their upcoming research pursuits.

Titled ”Healthcare System Using Blockchain” [2] the collaborative efforts of Gauri Lodha, Manu Pillai, Ankit Solanki, Sarvesh Sahasrabudhe, and Ashwini Jarali aim to tackle the crucial issue of data security in the healthcare domain. Their paper introduces a meticulously designed healthcare system leveraging blockchain technology, fostering secure management of personal medical data, and facilitating seamless interactions among Doctors, Patients, Insurance Companies, and Pharmacy or Medical shops. The central focus lies in exploring decentralized solutions for securely storing the substantial volume of patients’ critical data. A key challenge highlighted is the necessity for patients to possess requisite hardware and connectivity for system access, coupled with the imperative of uploading past health records. The paper endeavors to enhance both the security and accessibility of medical data, striving to create an integrated and secure ecosystem for healthcare stakeholders.

In the paper titled ”Converging Blockchain and Machine Learning for Healthcare” [3] authored by Sonali Vyas, Mahima Gupta, and Rakesh Yadav, the authors address challenges in the existing healthcare systems, particularly the requirement for patients to pay fees in bitcoins for accessing their records, leading to potential misuse and cost concerns. The paper proposes a solution by integrating Blockchain and Machine Learning to enhance efficiency while mitigating privacy issues in healthcare. The methodology involves combining these two technologies to revolutionize the sector, considering its direct impact on individuals’ lives. The authors highlight the potential of the proposed approach in addressing privacy concerns, which may not be adequately addressed by existing systems. However, the paper lacks practical implementation details, leaving room for further exploration of the proposed idea for real-time application and potential transformative impact in the healthcare domain.

Titled ”Blockchain for Secure EHRs Sharing in Mobile Cloud-Based E-Health Systems,” [4] this paper by Dinh C. Nguyen, Pubudu N. Pathirana, Ming Ding, and Andaruna Seneviratne addresses critical challenges in current EHRs sharing systems, focusing on data privacy and network security for e-health systems. The methodology involves deploying an Ethereum blockchain on the Amazon cloud, allowing medical entities to interact through a mobile Android application. The use of Ethereum blockchain and Smart Contracts addresses security concerns in the advanced storage of EHR models on the cloud. Results indicate that the proposed framework enables reliable and quick sharing of medical data over mobile cloud environments, surpassing conventional schemes and ensuring data security and privacy. While the research method for the new model is efficient, future scope discussions are lacking. This model could extend beyond healthcare to sectors like government exams, ensuring security for question papers and student data.

Titled ”Blockchain in Healthcare: A New Technology Benefit for Both Patients and Doctors,” [5] addresses the imperative need to enhance the structure, trust, procedures, and efficiency of healthcare services while providing qualified nourishment and care to patients. The paper aims to develop a system capable of detecting anomalies in a person’s health suite, notifying the designated healthcare supervisor for prompt and secure consultations. The methodology involves utilizing an Internet of Things (IoT) module to capture data from wearable devices worn by patients. Blockchain is employed for secure data storage, and a Machine Learning model is incorporated to detect anomalies and forecast potential scenarios. Despite the promising combination of IoT, ML, and Blockchain, the paper lacks detailed information about the actual implementation, leaving room for further exploration and practical insights into the proposed healthcare enhancement system.

The paper, ”Blockchain for Healthcare Management Systems: A Survey on Interoperability and Security” [6] authored by E. R. D. Villarreal et al., presents a thorough exploration of the application of blockchain technology in healthcare. The survey focuses on addressing challenges related to interoperability and security, aiming to enhance the efficiency of healthcare systems. Through an in-depth analysis of existing literature and research papers, the authors underscore the transformative potential of blockchain in healthcare management, emphasizing data integrity, security, and streamlined information exchange. Villarreal et al.’s survey delves into key aspects, including architectural mechanisms, consensus mechanisms, types of blockchain, platforms utilized, and the current progress in blockchain implementation within the healthcare sector. The paper underscores the significance of fostering trust and collaboration among healthcare organizations and professionals, emphasizing the need for effective utilization

of blockchain technology to enhance patient care and optimize data management.

In ”Evaluating the Impact of Blockchain Models for Secure and Trustworthy Electronic Healthcare Records” [7] authored by Mohammad Zarour, Md Tarique Jamal Ansari, Mamdouh Alenezi, Amal Krishna Sarkar, Mohd Faizan, Alka Agrawal, Rajeev Kumar, and Raees Ahmad Khan (Member, IEEE), a fuzzy-ANP-TOPSIS method is employed to analyze the influence of blockchain technology models on securing electronic healthcare records (EHRs). Through Multi-Criteria Decision Making (MCDM) analysis, the study evaluates various factors affecting blockchain models, assigns weights, and determines alternative rankings to assess overall EHR security impact. Results indicate the Private Blockchain model as the most effective and robust solution for healthcare blockchain technology, offering secure platforms for health data sharing and transforming patient EHR exchange and maintenance. The research serves as a guideline for future studies in healthcare blockchain technology, offering methodological approaches to address key issues and suggesting avenues for implementing blockchain-based services to enhance the healthcare sector.

In ”Blockchain and Machine Learning in EHR Security: A Systematic Review” [8] by Umer Zukaib, Xiaohui Cui, Mir Hassan (Member, IEEE), Sheetal Harris, Hassan Jalil Hadi, and Chengliang Zheng, the systematic review explores the applications of Blockchain (BC), Deep Learning (DL), and Federated Learning (FL) in healthcare, specifically focusing on Electronic Health Records (EHRs) security and interoperability. Employing the PRISMA technique, the study evaluates literature to identify solutions for EHR security issues, discussing BC-based architectural mechanisms for secure EHR storage and data exchange and tools and frameworks for ensuring privacy. Identified challenges include scalability, privacy concerns, lack of standard evaluation metrics, and decentralized storage/access. To tackle these, the study proposes integrating cloud storage with BC to ensure data integrity and security and suggests FL to preserve EHR privacy through a global model approach. Finally, a BC and cloud-based framework is proposed to enhance EHR security and interoperability while addressing big data challenges.

In ”A Systematic Analysis on Blockchain Integration With Healthcare Domain: Scope and Challenges” [9] by Sabita Khatri, Fahad Ahmed Alzahrani, Md Tarique Jamal Ansari, Alka Agrawal, Rajeev Kumar, and Raees Ahmad Khan (Member, IEEE), the study evaluates the integration and adoption of blockchain technology in healthcare, focusing on its potential for secure and decentralized patient-centered solutions. Analyzing 50 publications from 2015 to 2020, the research identifies a growing trend in blockchain healthcare research, particularly emphasizing data sharing, electronic health records, access controls, and clinical trials. Despite notable advancements, there exists a research gap regarding infrastructure development and other health systems. While Ethereum and Hyperledger are commonly utilized for implementation, there’s potential for broader adoption. However, research tends to prioritize architecture and platforms over automation processes using blockchain elements. Overall, blockchain technology displays promise in healthcare but remains in its nascent stages of development and implementation.

In ”A Blockchain-Based System for Healthcare Digital Twin” [10], the article presents a Healthcare Digital Twin (HDT) system aimed at addressing challenges in collecting and securely storing healthcare data. The HDT system, grounded in a defined mathematical model, focuses on integrating diverse data collection processes across three core stages: Pre-Hospital Admit, Patient Disease Diagnosis, and Surgical Operative Procedure. Leveraging blockchain technology in its architecture ensures data integrity and usability for various purposes, with protocol flows delineated for different use cases. Despite acknowledging the complexity of creating a full digital twin of a patient’s body, the article highlights opportunities to bridge this gap. The proposed model and system represent a significant step forward in this direction, with plans for further development and evaluation of their applicability and performance on the horizon.

Noshina Tariq, Ayesha Qamar, Muhammad Asim, and Farrukh Aslam Khan’s research article ”Blockchain and Smart Healthcare Security: A Survey” [11] addresses the security needs and difficulties in IoT-enabled smart healthcare systems, emphasizing the vulnerabilities and privacy problems. It analyzes several blockchain-based security solutions and investigates how blockchain technology might be used to address these security concerns. In addition to discussing the difficulties in using blockchain in the healthcare industry, the study highlights the advantages of blockchain adoption in data security. Additionally, it lists the most important security specifications for smart healthcare systems and offers a range of blockchain-based security options to meet these specifications. [12]

The authors of the study ”Healthcare Management System using Blockchain with ML Integration” suggest a system that improves healthcare data administration by utilizing blockchain technology and machine learning. Through a blockchain network, patient healthcare data is safely kept and exchanged between authorized medical professionals and patients. After that, the data is filtered and categorized by diseases using machine learning algorithms, giving academics and medical professionals access to important data for research. This creative method opens the door for further developments in data security and healthcare administration by demonstrating the possibilities of combining blockchain technology with machine learning in healthcare systems. [13] [14]

As we can see here we have summarised some of the research papers, which gives brief idea about the blockchain technology and gives a brief idea how we can use it in our Smart Healthcare Management System.

III. UML Diagrams

As here in the case of our SHMS ,we have identified some of the stakeholders. For the reference of which stakeholder

will have which access, here are the UML diagrams the main stakeholders.

Below is the use case diagram for the healthcare system.

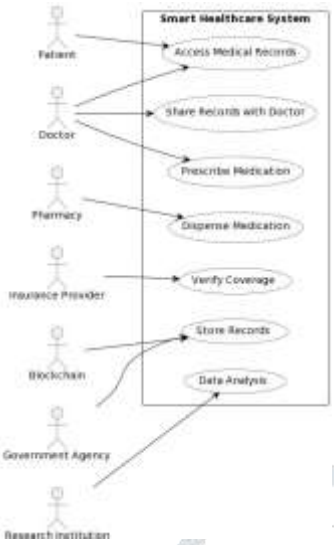

Fig. 1. Use Case Diagram

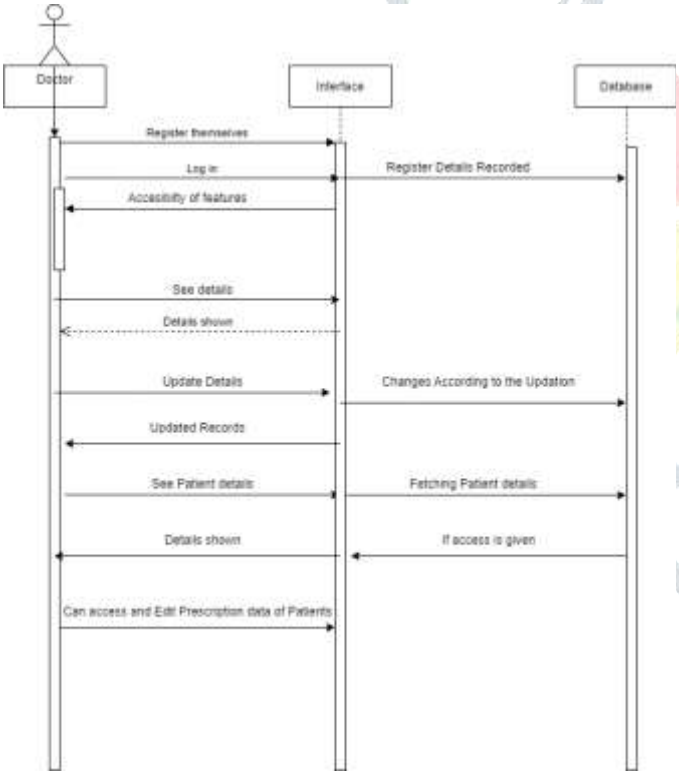

Fig. 2. Sequence Diagram - Doctor

This is the sequence diagram for Doctor.

Basically, from this figures we can get to know upto what extent and what will be the steps of any stakeholder so he can have the access of the smart healthcare management system.

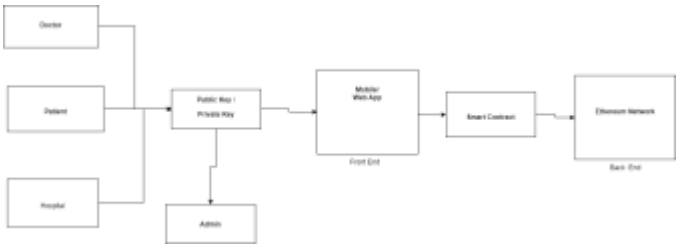

Fig. 3. Block diagram

The block diagram illustrates the overall architecture and components of the Smart Healthcare Management System. It provides a high-level overview of how different modules and stakeholders interact within the system. This diagram helps in visualizing the flow of information and processes in the healthcare management system. Basically these figures show how the system will work.

Fig. 4. Object diagram

This diagram shows which are the stakeholders for the Smart Healthcare Management System.

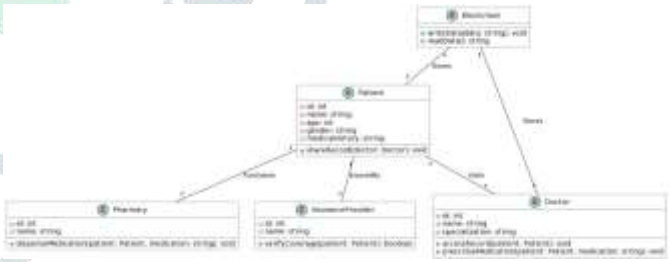

Fig. 5. Class Diagram

The class diagram illustrates the stakeholders and their relationships within the Smart Healthcare Management System (SHMS). It provides a visual representation of the different classes, their attributes, and the associations between them, offering insights into the structure and functionality of the healthcare system.

[15] [16]

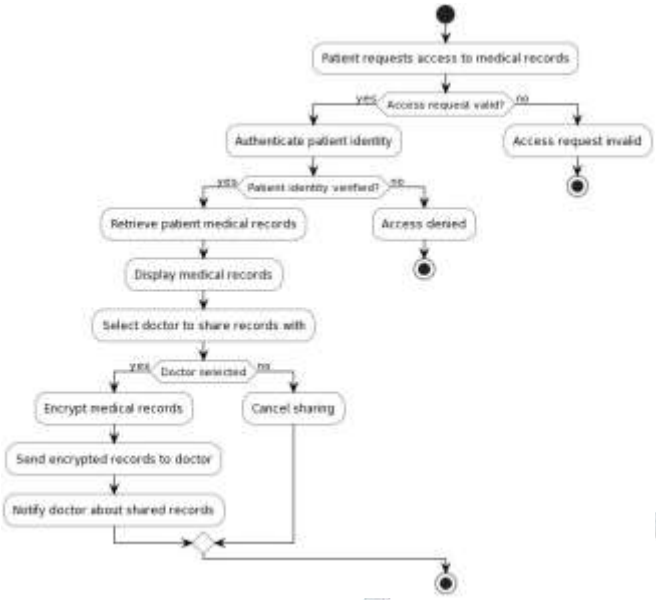

Fig. 6. Activity Diagram

The activity diagram showcases the flow of activities and processes within the Smart Healthcare Management System. It visually represents the sequence of actions taken by stakeholders, such as doctors or patients, in interacting with the system. The diagram helps in understanding the steps involved in accessing and utilizing the healthcare management system efficiently

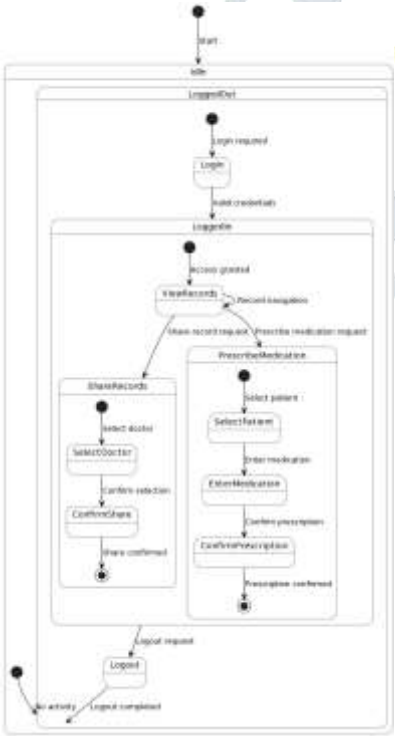

Fig. 7. State Machine Diagram

The state machine diagram outlines the different states and transitions that occur within the Smart Healthcare Management System. It visually represents how the system responds to various events and inputs, showcasing the behavior and interactions between different components. This diagram aids in understanding the system's functionality and the flow of operations within the healthcare management system

IV. Limitations

The primary challenges in smart healthcare systems revolve around data security and privacy concerns, as highlighted in various papers. In smart healthcare, there are big problems with keeping patient information safe and private. Some papers suggest using blockchain to fix this, but it's not easy to put into action. Connecting different technologies, like blockchain and machines, is also tricky. People worry about paying for healthcare using things like Bitcoin, and it might lead to misuse and cost issues. The internet and needing good connections can be a problem too. Some papers talk about fraud and unnecessary medical tests because of how data is stored. But, many of these papers don't give enough details on how to actually make these solutions work in real life. [17] [18]

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