www.ijirses.com *ISSN: 2583-1658 (Online) | Volume: 3 Issue: 5 | 2023*

Blockchain Based Application for Healthcare Information

Chidi Ukamaka Betrand[1,*], Oluchukwu Uzoamaka Ekwealor [2], Chinazo Juliet Onyema [3]

[1,3]Department of Computer Science, School of Information and Communication Technology, Federal University of Technology Owerri, Imo State Nigeria,

[2]Department of Computer Science, Faculty of Physical Science, Nnamdi Azikiwe University Awka Anambra State

Abstract: *This research work focuses on the development of Healthcare information system that uses the Blockchain Technology. This research was carried out to mitigate the problem and challenges encountered with the current paper based record and the Electronic Health record. Blockchain Health Technology is efficient in sorting, searching, handling, archiving and transmitting patient file. For the sake of implementing this work, JavaScript, HTML, and Solidity were employed as the programming languages. The system was developed using Searchable Symmetric Encryption (SSE) in the healthcare management industry to secure the confidentiality of the Electronic Health Record (EHR) without compromising its usability and accessibility. The proposed system is a Blockchain-based healthcare management system with two side verifiability. This research has reviewed application of Blockchain in healthcare information management, it has analyzed the problems of the existing system and proposed a better system for transferring data in a transparent fail-safe manner using the blockchain. The proposed system has been designed and tested to be efficient and effective for use in healthcare information management.*

Keywords: *Blockchain, Distributed Ledger Technology, Diagnosis, Healthcare, Patient, Radiology, Charges*

1. Introduction

Blockchain, or Distributed Ledger Technology (DLT), is a system that allows several users to access and update the same set of records at the same time. Information, including any alterations, deletions, and additions, is recorded in a manner that ensures its complete safety, security, truthfulness, and immutability across time. This implies that the blockchain's initial data blocks are preserved and verified, and that the blockchain also serves as an immutable, comprehensive record for the modifications of data. Nakamoto**,** [1] presented a fundamental article on the cryptocurrency Bitcoin, where ultra-secure data storage is crucial [2]. This marked the birth of blockchain technology. The article proposed the use of cryptography and distributed computing theory to build a trustworthy Bitcoin trading platform. Blockchain technology has attracted the attention of developers and researchers interested in its potential applications across a wide range of industries since its inception in 2018 [3]. One such industry is the healthcare industry, and medical systems and related health-related systems are prime candidates for implementations of blockchain technology. In order to prevent the inappropriate use of personal health information, MEDShare was created. In order to monitor and manage cloud-based medical records, the MEDshare team used blockchain technology. MEDshare keeps immutable logs of all system activity and data, allowing them to track which organizations are using their data custodian system and from where.

Concerns about patient privacy and data accessibility in healthcare service delivery have been addressed in a number of ways. Since the beginning of time, the healthcare industry has relied mostly on a paper-based record keeping method [4]. Although this paper-based system is still in use, it has been shown to be inadequate for ensuring that records are always accessible and may be accessed at any moment. This kind of documentation has therefore increased the time and effort required to offer healthcare services. Another problem with paper-based systems is that there is no guarantee for information backup, patients cannot see their medical history and records are not organized properly [5].

These concerns about personal information may be addressed with the use of blockchain technology. In this context, blockchain is a distributed, encrypted database that acts as an immutable public ledger. In order to protect the confidentiality of patients' medical information, blockchain technology creates a permanent public ledger of all verified transactions between all parties involved. The ability to conduct transactions with complete anonymity and data integrity preserved is a fundamental incentive for adopting blockchain technology [6].

1.1. Significance of this Study

The health care industry's issues can be reduced to an absolute minimum thanks to the blockchain technology. This might be achieved by decreasing patient healthcare access prices and offering a speedy and secure method for data interchange between medical staff and patients. This technology is receiving more attention as a result of the rapid rise in issues facing the healthcare sector. Concerns about patient privacy and data accessibility in healthcare service delivery have been addressed in a number of ways. Since the beginning of time, the healthcare industry has relied mostly on a paper-based record keeping method [7]. Although this paper-based system is still in use, it has been shown to be inadequate for ensuring that records are always accessible and may be accessed at any moment. This kind of documentation has therefore increased the time and effort required to offer healthcare services. Another problem with paper-based systems is that there is no guarantee for information backup, patients cannot see their medical history, and records are not organized properly [3, 7-8]

1.2. Specific Objectives of this Study

The Blockchain technology and its significant needs in the healthcare sector cannot be underated, this study proposes thus:

Identifying the Unified Work-Flow Process of Blockchain technology realization in providing healthcare amenities

Utilizing the blockchain technology for improved healthcare system

Inculcating the blockchain technology for the revival of the health sector

2. Related Works

Blockchain technology is being utilized more and more in a variety of industries as a decentralized method for data recording and transactions. This is maintaining its numerous distinctive features, including the permission of data sharing with the highest level of security, the validation of transaction processes, and the avoidance of single point transaction system failure, to name just a few [9–10]. Blockchain-based research and applications have showed promise in strengthening global health systems and potentially lowering disease burden, mortality, morbidity, and monetary expenditures.

Xhafa *et al*. [11] offered an alternative architecture for a cloud-based EHR system that included attribute-based encryption. Using attribute-based encryption, the solution brought together the disparate pieces of data stored on several distinct cloud servers in a way that a doctor could easily access and read. The system architecture comprised Authorization and Access for Doctors, as well as Storage and Access for Patient Health Information, facilitating the sharing of patient health records across physicians.

For remote patient data monitoring, Daraghmi *et al*. (2019), [12] developed a system based on the Internet of Things (IoT) they called Health Chain. However, it was acknowledged that there was the danger of leaking of information belonging to patients and loss of privacy due to the data obtained from the IoT device and kept in a centralized data storage. It was also possible that, in the case of a server failure, critical patient information may be lost forever. Medical conflicts may be avoided with the help of the Health Chain system, which connects blockchain and IoT devices in such a way that data cannot be deleted or altered. Of course, this is one of the notable feature of the blockchain technology: the immutability of data after it has been recorded in the blockchain, meaning that the information stored there cannot be altered once it has been recorded. According to Patel, 2018, [13] a proposal and prototype for health data sharing on Hyper Ledger Fabric's permissioned blockchain were built, along with a mobile app that gave data owners control over who may access their data. The system included wearable sensors that collect user healthcare data. Before being stored on the blockchain, the health data would be analyzed and synchronized to a cloud server. Given the volume of information available from wearable health devices, the Merkle tree was selected to store just the Merkle root on a blockchain transaction. To guarantee that the data blocks sent between peers on a peer-to-peer network are complete, undamaged, and unmodified, cryptocurrencies utilize Merkle roots, a simple mathematical approach to validate the data on a Merkle tree. Key to the computation needed to sustain cryptocurrencies like Bitcoin and Ethereum, they are Information on medical care, insurance claims, and related actions (such as data requests) were also recorded in the blockchain. To further preserve individuals' anonymity, channeling was suggested alongside the program.

Wang et al, [14] on blockchain technology (BCT) adoption in a three-echelon supply chain, the upstream sellers that offers trade credits to capital-constained downstream buyers. It was observed that trade credit management cost saving and repayment risk-sharing effects, as facilitated by the BCT. Huang *et al*, [15]

opined that due to the slowdown and instability in the stock market of recent, the art market has grown to be the third largest investment market. The project applied the blockchain technology to Art Banks. The proposed protocol satisfies the following security requirements: identities' mutual authentication, non-repudiation between every two parties, and other major security requirements based on blockchain.

Chen et *al*, [16] in a bit to solve the challenge of adding blockchain technology to education combined artificial intelligence technology to improve students' interest in learning. Samples were taken from about 821 teachers tutored by 39 teachers and the intelligent classroom from the average scores showed a great improvement on the students. Cutitoi, [17] presented a systematically reviews on immersive virtual reality experiences in the retail metaverse. Their findings indicated that real-time sensor data and machine vision algorithms enhance customer engagement behaviors across virtual marketplaces and immersive interconnected virtual worlds. It was clarifed that big data analytics, operational modeling tools, customer monitoring systems, and semantic vector search technology shape consumption patterns and buying habits in immersive virtual worlds. Interoperability in healthcare has traditionally been focused around data exchange between business entities, for example, different hospital systems [18]. In contrast, there has recently been a push for patient-driven interoperability, which involves patient-mediated and patient-driven health data interchange. However, in order for this kind of data sharing to be successful at scale, additional issues and requirements related to security and privacy, technology, incentives, and governance must be addressed. How the blockchain technology could ease transitions through digital access rules, data aggregation and liquidity, patient identity, and data immutability were all taken into account in their study. A trend in many industries, blockchain technology has been developed for more than ten years. The oil and gas industry is not exempt from this. According to Lu et al. [19], blockchain technology has been used to considerably increase the management level, efficiency, and data security as the oil and gas industry increasingly moves towards intelligence and digitalization. a description of the four ways the oil and gas sector is using the blockchain: for trading, management and decision-making, oversight, and cyber security. Wan *et al.*, [20] on Blockchain technology in empowering crowd funding decision-making of marine ranching[ ], the supply chain models of consumer crowd funding and pre-sale crowd funding under the conventional mode and BT mode were built and solved using multi-level programming and the backward induction approach, and the results were balanced. The research shows that: (1) The consumer crowdfunding approach is more valuable for the supply chain overall than the pre-sale crowd funding method for the marine ranching leading enterprise. The value of each component in the supply chain system may also be increased with the adoption of BT. (2) The industry's top marine ranching company considers the value of both crowd funding users and regular customers, which will lower their own worth and raise the value of other subjects in the supply chain. The increased consumer value of crowd funding products will result from customers' increased awareness of the qualities of the products. (3) As the green qualities of items improve, so do the values of the top company, the store, the crowd sourcing site, and the customers, as well as the supply chain as a whole. (4) All participants in the crowd funding supply chain system have the common aim of increasing product sales, which promotes the economic and environmental value of businesses.

Ebekozien *et al.*, [21] opined that Some e-commerce platforms that permit businesses to set up third-party storefronts on them have developed their own blockchain technologies recently and have made this technology available to businesses publicly. They took into account four theoretical models to investigate the relationship between the joining the platform blockchain technology strategy and the channel encroachment choice for fresh agricultural product enterprises. The main findings show that consumer sensitivity to freshness-keeping effort level of fresh agricultural product, consumer trust degree of freshness-keeping effort level, and unit blockchain operation cost are dependent on whether firms set up third-party stores on the platforms or not. Additionally, businesses will be more inclined to use the platform blockchain technology if they establish third-party stores.

Haque *et al.*, [22] on Sustainable and efficient E-learning internet of things system through blockchain technology recommended the use of blockchain technology and IoT to protect the online education system. This design uses layers of various IoT and Blockchain ideas. The suggested architecture's block diagram also shows how students may use Blockchain technology to access or communicate safely with the online learning system. Universities and colleges may enhance their distant learning programs and boost efficiency without harming their academic operations by utilizing the proposed e-learning IoT architecture.

The study also discovered that e-learning had a favorable effect on students' learning experiences and the standard of education as a whole. Additionally, it showed a notable improvement in their adaptability and academic performance.

Ilyas *et al.*, [23] established a powerful method for detecting and preventing DDoS assaults using optimization-based deep learning, taking into account the blockchain network and smart contracts. The traffic is evaluated based on the user request, and a smart contract verification is done to locate the authenticated user. Following the verification, the authenticated user receives a response, and the suspicious traffic is used by the Poaching Raptor Optimization-based deep neural network (Poaching Raptor-based DNN) to detect DDoS attacks. The classifier is tuned using the proposed optimization algorithm to minimize training loss. To improve the detection accuracy, the suggested method was created by combining the raptor's habitual practice with concurrent behavior, hunting style, and lobo poaching behavior. The nonattacker is addressed following the attack detection, and the attacker is stopped by providing the IP/MAC address in the log file. Evaluation of the suggested method's performance yielded values of 96.3%, 98.22%, 3.33%, and 95.12%, respectively, for recall, precision, FPR, and accuracy.

3. Description of the proposed framework

The patient record and electronic medical record (EMR), which are mostly related to hospital matters, are the data to be stored in the blockchain-based architecture. These data are stored in a database system that uses blockchain technology and is connected to the suggested application. The database has more than 50 tables total, each of which contains information about a patient, doctor, hospital, and electronic medical record. The "patient" table contains the personal information on patients, including name, age, gender, contact information, and guardian. For the benefit of medical professionals and authorities, the patient's diseases and allergies are also recorded, along with their symptoms, which are necessary for creating a prediction model. Every time a patient visits a doctor at a hospital, their records are kept in a table called "emr." The data that is saved includes the visit date, the attending physician, the name of the hospital, the title, a description of the visit, a prescription, and any pertinent images like x-rays. To distinguish the EMR records included in the table, the records are divided into consultation and surgery categories and given the initials C and S. With this knowledge, medical professionals can find out the patient's medical history and determine the best course of action based on the patient's state of health. Additionally, the "doctor" and "hospital" tables record the personal information of the doctor in charge as well as contact information for a variety of hospitals. Researchers and other healthcare professionals may be interested in learning more about the patient's records, and they can get in touch with the specific doctor or institution directly. When a patient record is stored, the data for the patient, the doctor, and the hospital are each represented by a distinct ID. These IDs serve as the foreign keys in the "emr" database for reference purposes rather than duplicating the data and serve as the main keys in their individual tables to uniquely identify them. However, the database system also automatically assigns a record ID to each EMR.

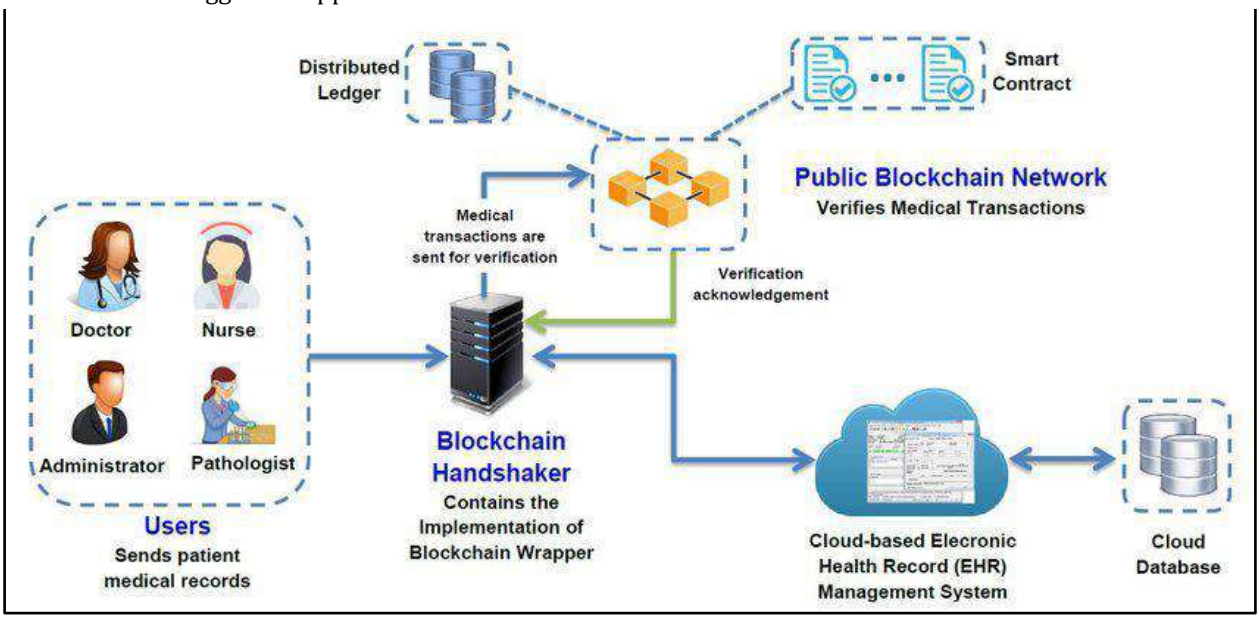

Figure 1: The proposed blockchain framework

Participants must have access rights to the blockchain before doing any operations on the EMR, and CA handles this issue. Additionally serving as the administrator, CA is responsible for deleting or adding blockchain members. This will ensure that only those who are linked to the data in the blockchain can read it, stop hackers from accessing this private data, and enhance data privacy. The registration procedure is available to everyone who wants to access the data in the blockchain, including healthcare providers, healthcare authorities, and financial parties.Through the registration procedure, users become participants in the blockchain and are given an ID, a public key, a private key, and an E-Certificate. Data is typically encrypted using a public key and decrypted using a private key. The unique name and identification card of a blockchain member are represented, respectively, by ID and E-Certificate. After a patient sees a doctor, the EMR must be updated with the results of the consultation and the diagnosis, and the information must be saved in the blockchain.

In addition to consultation-related information, procedures that are carried out on the patients are also documented. Images that are relevant, such scanned X-rays or reference photos, can be put into the blockchain. In order to update their patient medical records, doctors must acquire the patients' consent in this procedure. As a component of the blockchain system, the healthcare authorities would certainly wish to examine the patient data and EMR to learn about the patient's symptoms and course of treatment. Because the system is SAAS-based, it may be disseminated to many hospitals and medical facilities.

4. The Blockchain Healthcare Application

The main menu of the Blockchain Healthcare Application is as shown below. An Admin gets insights of the total sum of Invoices, Bills and Payments. Also, the total number of doctors, patients, and available beds with financial commitments.

Admin can also add new users for specific role wise by using this module.

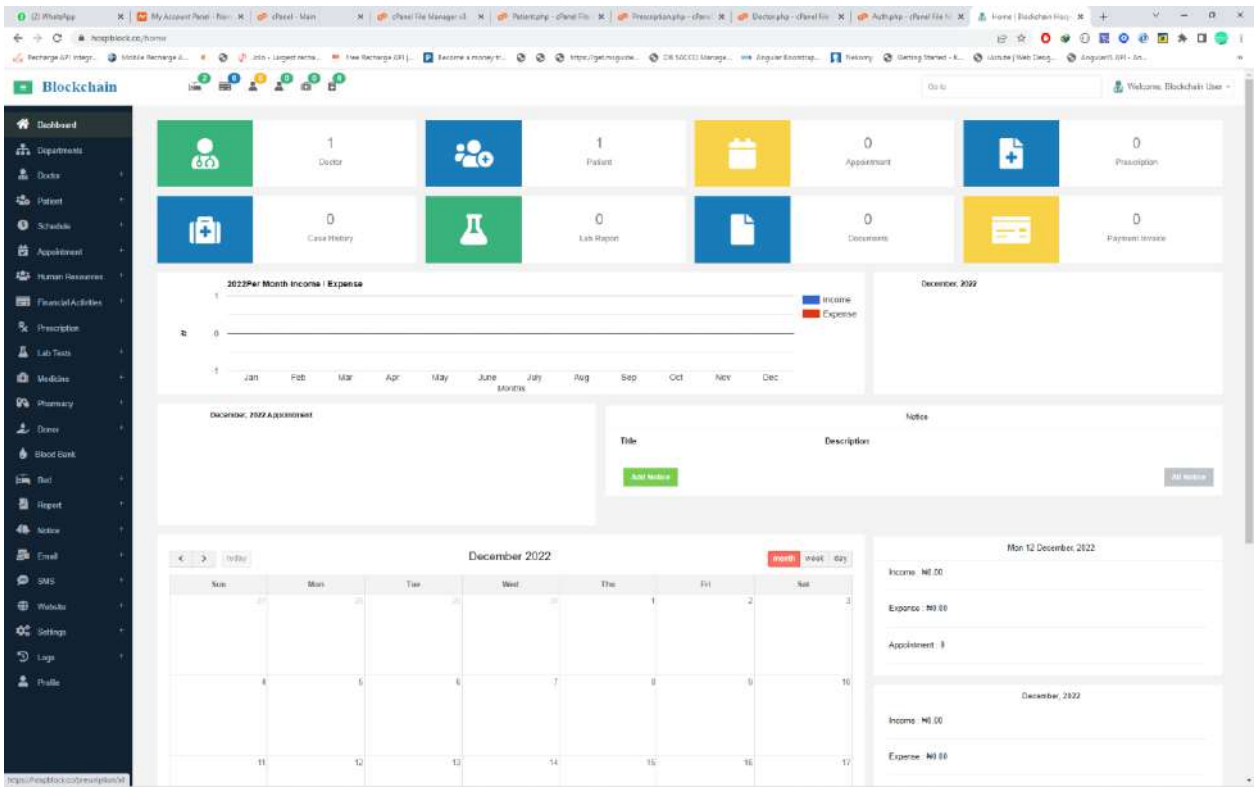

Figure 2: Main Menu

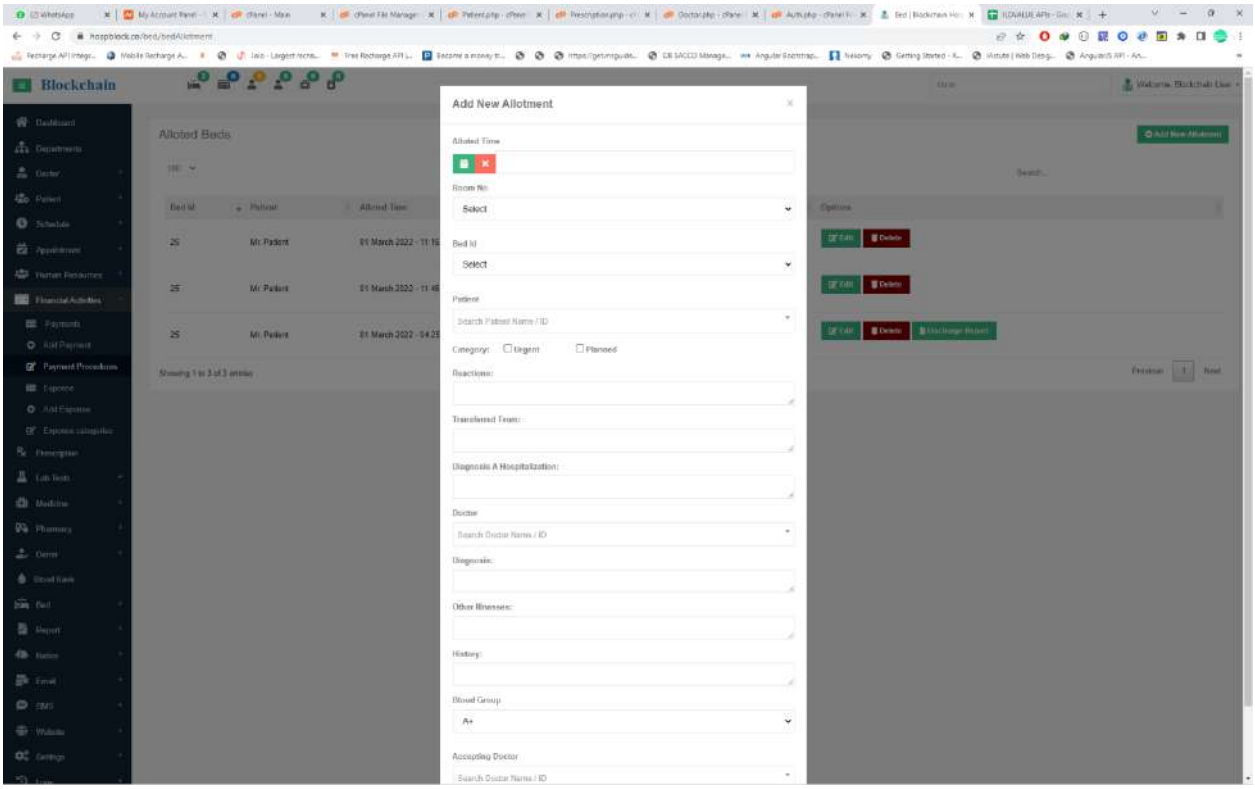

Figure 3: Patients/Visitors Log book

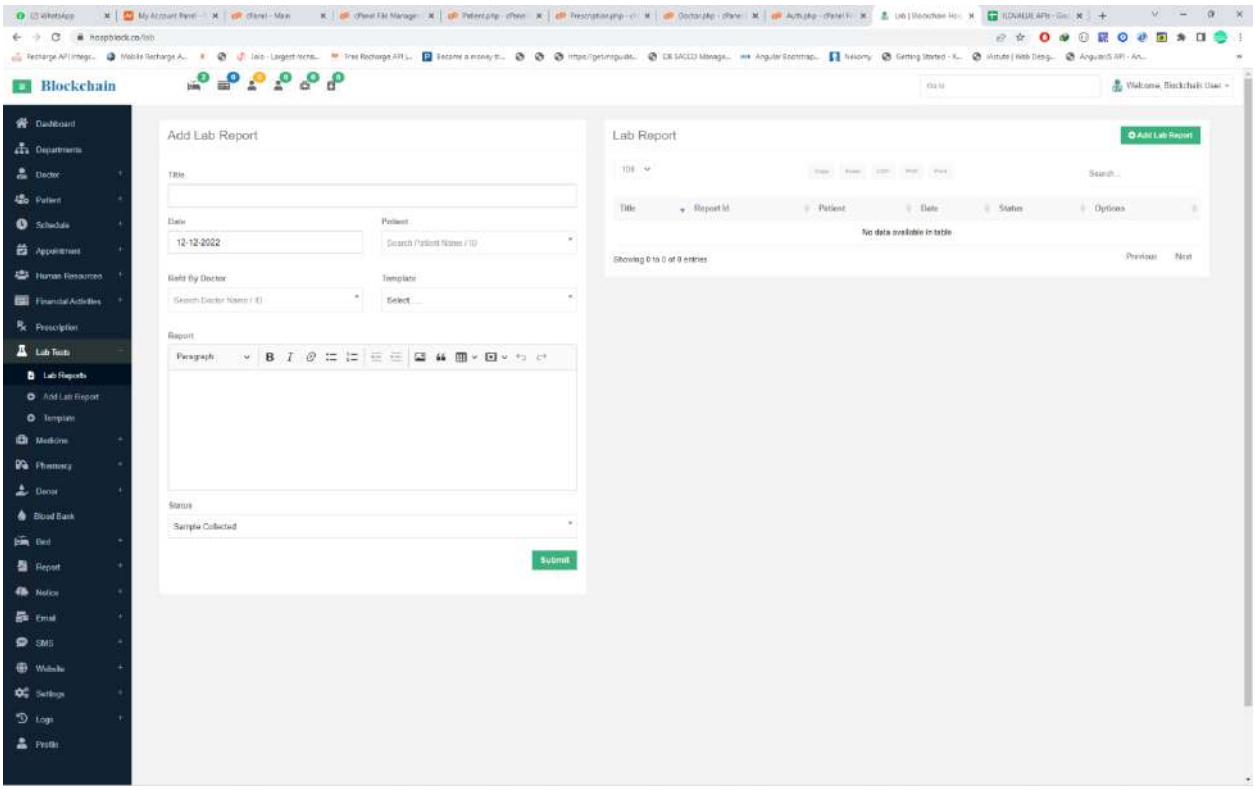

Figure 4: Diagnosis Menu Report

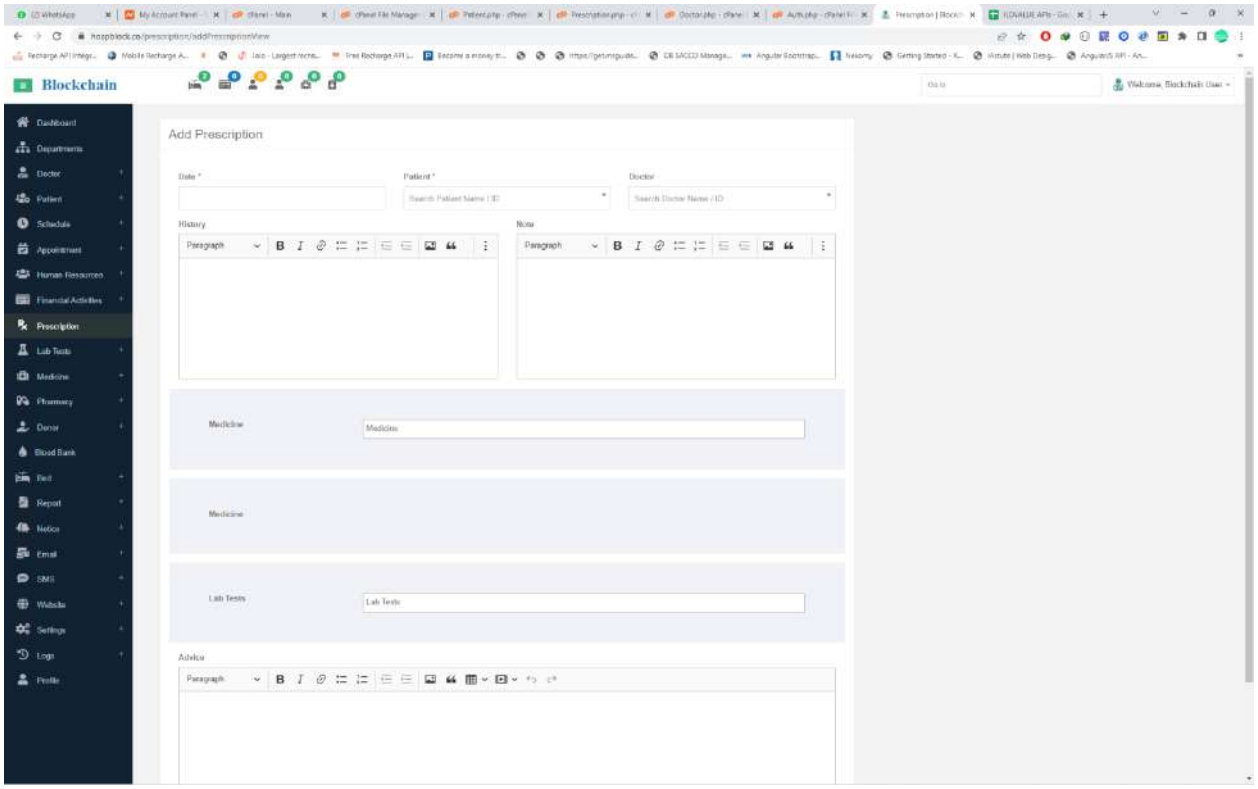

Figure 5: Prescription Menu

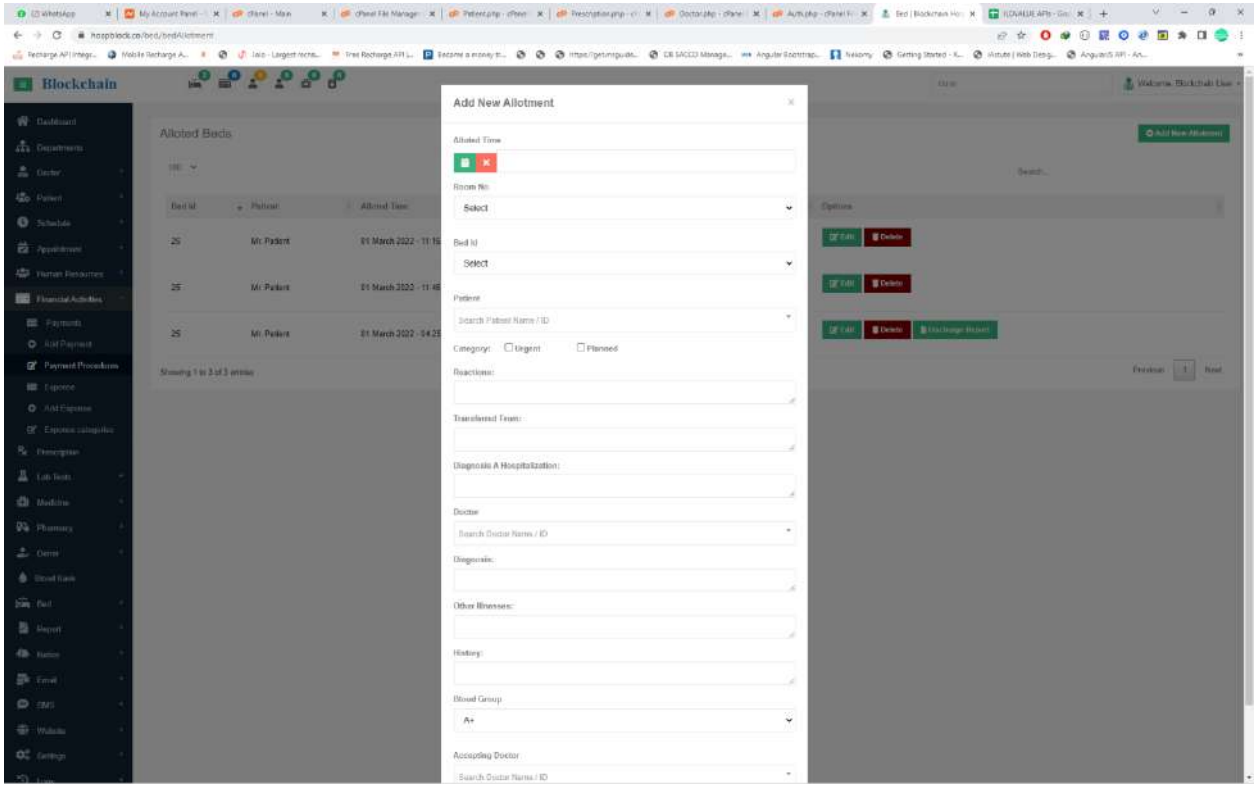

Figure 6: Bed Availability Graphic View

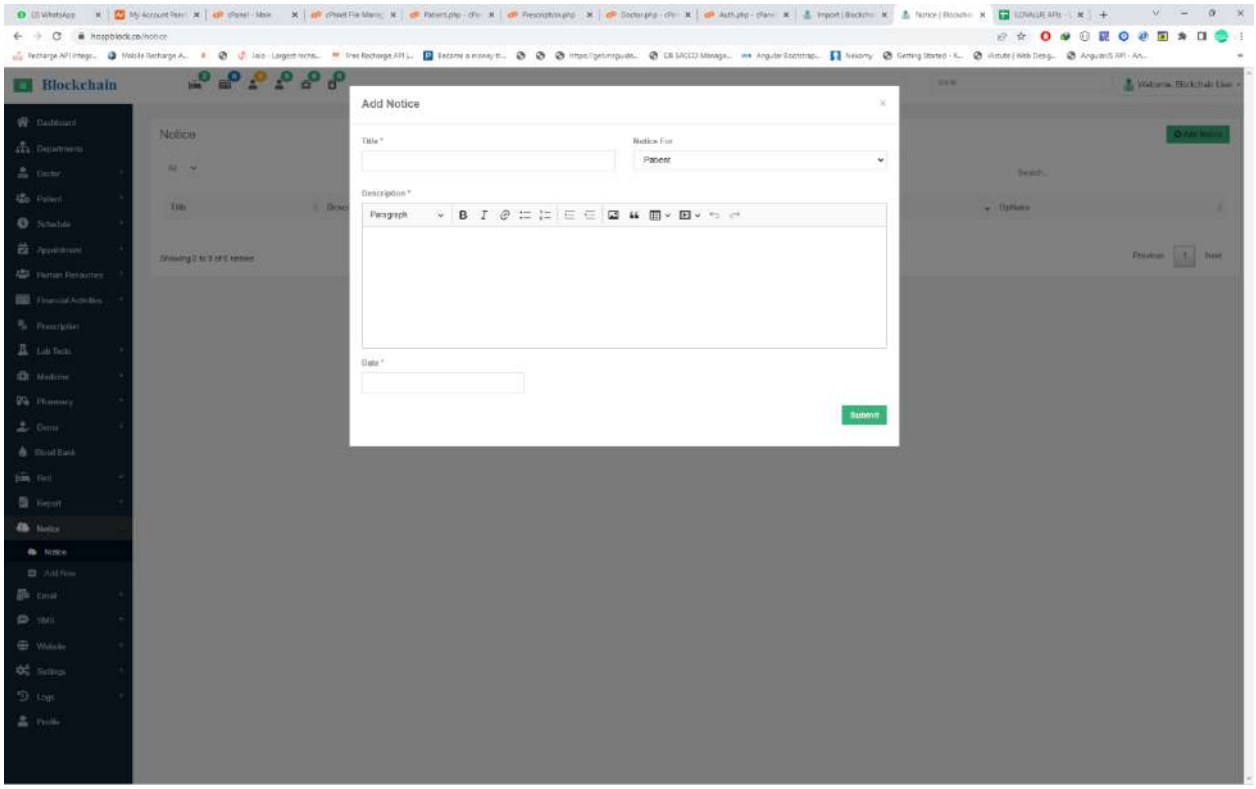

Figure 7: Testimonials

5. Conclusion

The interchange of health information may be secure, thanks to blockchain technology which also forbids unhealthy data tampering among the many parties. While preventing data repudiation, it promotes data security and personal privacy while allowing liberty. This study project has been able to examine a number of Blockchain application cases in the healthcare industry. The study has opened up several research avenues for more efficient blockchain integration in healthcare with less resources needed. The adoption of related advanced technologies in the ecosystem will have a significant impact on the potential of blockchain in the healthcare sector. This involves, among other things, system tracing, insurance, medicine tracing, and clinical trials. Overall, the delivery of healthcare services will be greatly improved and revolutionized by blockchain technology.

References

[1] Nakamoto S (2008). Bitcoin: A peer-to-peer electronic cash system. Decentralized business review, 21260

[2] Jin H, Luo Y, Li P, Mathew J (2019).A Review of Secure and Privacy-Preserving Medical Data Sharing. IEEE Access, 7:61656–61669. https://doi.org/10.1109/access.2019.2916503

[3] Wang, S., Zhang, D., & Zhang, Y. (2019). Blockchain-based personal health records sharing scheme with data integrity verifiable. IEEE Access, 1–1. https://doi.org/10.1109/access.2019.2931531

[4] Liu, X., Wang, Z., Jin, C., Li, F., & Li, G. (2019). A Blockchain-Based Medical Data Sharing and Protection Scheme. IEEE Access, 7, 118943–118953. https://doi.org/10.1109/access.2019.2937685

[5] Shahnaz, A., Qamar, U., & Khalid, A. (2019). Using Blockchain for Electronic Health Records. IEEE Access, 7, 147782–147795. https://doi.org/10.1109/access.2019.2946373

[6] Trautman, L. J. (2016, May 28). Is Disruptive Blockchain Technology the Future of Financial Services? Papers.ssrn.com. https://ssrn.com/abstract=2786186

[7] Bhattacharya S, Singh A, Hossain MM (2019) Strengthening public health surveillance through blockchain technology. AIMS public health, 6(3):326.

[8] Zheng Z, Xie S, Dai HN, Chen X, Wang H (2018) Blockchain challenges and opportunities: A survey. *International journal of web and grid services*, *14*(4):352-375.

[9] Kassab, M. H., DeFranco, J., Malas, T., Laplante, P., destefanis, & Graciano Neto, V. V. (2019). Exploring Research in Blockchain for Healthcare and a Roadmap for the Future. IEEE Transactions on Emerging Topics in Computing, 1–1. https://doi.org/10.1109/TETC.2019.2936881

[10] Azogu I., Norta, A., Papper, I., Longo, J., & Draheim, D. (2019). A Framework for the Adoption of Blockchain Technology in Healthcare Information Management Systems. Proceedings of the 12th International Conference on Theory and Practice of Electronic Governance. https://doi.org/10.1145/3326365.3326405

[11] Xhafa, F., Carretero, J., Dorronsoro, B., & Alba, E. (2009). A TABU SEARCH ALGORITHM FOR SCHEDULING INDEPENDENT JOBS IN COMPUTATIONAL GRIDS. Computing and Informatics, 28, 237–250.

[12] Daraghmi, E.-Y., Daraghmi, Y.-A., & Yuan, S.-M. (2019). MedChain: A Design of Blockchain-Based System for Medical Records Access and Permissions Management. IEEE Access, 7, 164595–164613. https://doi.org/10.1109/access.2019.2952942

[13] Patel, V. (2018). A framework for secure and decentralized sharing of medical imaging data via blockchain consensus. Health Informatics Journal, 146045821876969. https://doi.org/10.1177/1460458218769699

[14] Wang C., Chen, X., Xu, X., & Jin, W. (2023). Financing and operating strategies for blockchain technology-driven accounts receivable chains. *European Journal of Operational Research*, *304*(3), 1279-1295.

[15] Huang D. C., Liu, L. C., Deng, Y. Y., & Chen, C. L. (2023). An artwork rental system based on blockchain technology. *Symmetry*, *15*(2), 341.

[16] Chen Y. (2022). The Impact of Artificial Intelligence and Blockchain Technology on the Development of Modern Educational Technology. *Mobile Information Systems*, *2022*.

[17] Cutitoi A. C. (2022). Machine Vision Algorithms, Sensory Data Mining Techniques, and Geospatial Mapping Tools in the Blockchain-based Virtual Economy. Review of Contemporary Philosophy, (21), 223-238

[18] Gordon W. J., & Catalini, C. (2018). Blockchain technology for healthcare: facilitating the transition to patient-driven interoperability. *Computational and structural biotechnology journal*, *16*, 224-230.

[19] Lu, H., Huang, K., Azimi, M., & Guo, L. (2019). Blockchain technology in the oil and gas industry: A review of applications, opportunities, challenges, and risks. Ieee Access, 7, 41426-41444.

[20] Wan, X., Teng, Z., Li, Q., & Deveci, M. (2023). Blockchain technology empowers the crowdfunding decision-making of marine ranching. *Expert Systems with Applications*, *221*, 119685.

[21] Ebekozien, A., Aigbavboa, C., & Samsurijan, M. S. (2023). An appraisal of blockchain technology relevance in the 21st century Nigerian construction industry: perspective from the built environment professionals. *Journal of Global Operations and Strategic Sourcing*, *16*(1), 142-160.

[22] Haque, M. A., Haque, S., Zeba, S., Kumar, K., Ahmad, S., Rahman, M., ... & Ahmed, L. (2023). Sustainable and efficient E-learning internet of things system through blockchain technology. *E-Learning and Digital Media*, 20427530231156711.

[23] Ilyas, B., Kumar, A., Setitra, M. A., Bensalem, Z. A., & Lei, H. (2023). Prevention of DDoS attacks using an optimized deep learning approach in blockchain technology. *Transactions on Emerging Telecommunications Technologies*, e4729.