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ELECTRONIC MEDICAL RECORD (EMR) DESIGN FOR HOSPITAL USING BLOCKCHAIN TECHNOLOGY

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ABSTRAK

Kebocoran data di Indonesia masih dianggap sangat umum sehingga menyebabkan rendahnya tingkat kepercayaan masyarakat Indonesia dalam hal penyimpanan data pribadi secara online. Penggunaan blockchain masih belum populer di Indonesia. Kedua teknologi ini dapat digabungkan untuk menghasilkan hasil teknis terbaik, terutama di bidang keamanan, berkat kemajuan teknologi di industri perawatan kesehatan dan teknologi blockchain. Implementasi blockchain EMR juga mampu memfasilitasi jangkauan rekam medis pasien, memungkinkan setiap pasien yang menerima rawat jalan atau perawatan lain di salah satu rumah sakit XYZ dengan mudah mengintegrasikan rekam medis mereka ketika mencari perawatan di cabang lain, bahkan jika Rumah sakit XYZ baru saja mengakuisisi rumah sakit lain. Transmisi data dengan sistem standar masih diragukan karena tidak ada jaminan keamanan data karena keamanan rumah sakit cabang baru dan rumah sakit yang diakuisisi tidak dapat terjamin keamanannya. Blockchain EMR dapat membantu semua rumah sakit di masa depan dengan meredakan kekhawatiran mereka dan memfasilitasi mobilisasi sistem rumah sakit, khususnya di departemen data pasien.

Keywords :
Blockchain, Medical History, Security, Patient Data

ABSTRACT

Data leakage in indonesia is still regarded as being extremely common, which has led to a low level of confidence among indonesians when it comes to storing their personal data online. The use of blockchain is still not popular in Indonesia. These two technologies may be merged to produce the best technical outcomes, especially in the security area, thanks to technological advancements in the healthcare industry and blockchain technology. The implementation of the EMR blockchain is also capable of facilitating the reach of the patient's medical record history, allowing each patient who receives outpatient or other treatment at one of the XYZ hospitals to easily integrate their medical records when seeking treatment at other branches, even if XYZ hospital just recently acquired another hospital. Data transmission with the standard system is still in doubt since there is no guarantee of the security of the data because the security of the new branch hospital and the acquired hospital cannot be guaranteed securely. The EMR blockchain can help all hospitals in the future by easing their concerns and facilitating hospital system mobilization, particularly in the patient data department.

INTRODUCTION

The adoption of technology has accelerated in Indonesia (Hasan & Mardhani, 2021). The Pulse of Asia reported that up to 68.7% of respondents from Indonesia said they would adopt personal digital health technologies during the next three years to better their health. It is evident from the survey's findings that Indonesians are aware of the use of information technology in the healthcare industry. According to a separate poll by the Profiles Network Office, 42% of Indonesians use personal health technologies and gadgets to keep an eye on their wellbeing. As a result, Indonesia is one of the nations that has a large potential to absorb these technical innovations in the health sector (Mubarak & Petraite, 2020).

From the technological advancements made in the field of health care, there are several adjustments that must be made in order to raise the quality of patient care and patient support. The most notable data corruption issue currently occurring in Indonesia. According to research conducted by Katadata.co.id, 1.04 million accounts in Indonesia will experience data loss during the second quarter of 2022. This number represents a 143 percent increase over the roughly 430,1 billion accounts that would experience data loss during the first quarter of 2022.

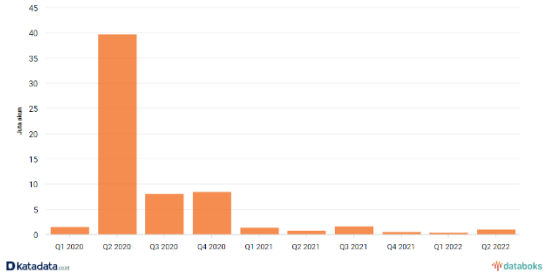

Figure 1. Trends in Data leakage in Indonesia

Data leakage in Indonesia is still regarded as being extremely common, which has led to a low level of confidence among Indonesians when it comes to storing their personal data online. As a result, technology advances to provide a brand-new remedy known as Blockchain. A distributed ledger technology, such as blockchain in general, is a potential one for traceability systems (Reimers et al., 2019) .

The use of blockchain is still not popular in Indonesia. Robby, the director of Rekeningku.com, claimed that due to widespread misuse, such as the usage of deceptive tokens that lead users to lose money, not many people are aware with blockchain technology. Additionally, he said that of the 80 million young people, less than 1% are familiar with the blockchain itself (Strebinger & Treiblmaier, 2022).

These two technologies may be merged to produce the best technical outcomes, especially in the security area, thanks to technological advancements in the healthcare industry and blockchain technology. All patient data may be stored using EMR and blockchain technology so that both patient information and medical records cannot be modified. The EMR blockchain, which enables the mobility of the current system in the hospital with newly acquired hospitals or new hospitals being created, may also help become a new breakthrough in the business of hospitals that have used it. The EMR's convenience is thought to be able to coordinate the existing security measures with the hospital system that is being purchased. The

implementation of the EMR blockchain is also capable of facilitating the reach of the patient's medical record history, allowing each patient who receives outpatient or other treatment at one of the XYZ hospitals to easily integrate their medical records when seeking treatment at other branches, even if XYZ hospital just recently acquired another hospital. In addition, doctors will find it simpler because each patient already has a documented diagnosis, making it simpler to establish a diagnosis and choose the best medication to reduce the likelihood of a diagnosis.

The EMR Blockchain can be a solution to overcome the anxiety experienced by each stakeholder in carrying out treatment at the hospital, improving and optimizing the patient's journey at the hospital from a design standpoint. This research will focus on the initial design of the EMR blockchain starting from the anxiety experienced by each stakeholder in carrying out treatment at the hospital. system that will be made.

LITERATURE REVIEW

For the purpose of disambiguation and properly defining terms within context of the research, this chapter will provide related theories consisting of inclusive theories and exclusive theories and cover reviews of previous researches with relevant topics to provide bigger picture for readers.

1. Hospital Information System

A system of information that focuses on the hospital setting is called the Hospital Information System (HIS). The hospital's extremely intricate organizational and operational structure is complemented by the information management system. Its scope, substance, and organization all have various purposes. contains a number of programs and subsystems that make the most use of computerization and information technology to streamline the delivery of medical services. HIS stands for a fully integrated hospital information system that facilitates activities (Hospital Information System). The management of hospital operations is the main area of concentration. However, it is possible to gather, examine, and use the data provided by the system for research, project management, and other purposes. The Patient Care Information System and the Managerial Information System are characterized as the two main systems that make up HIS (Augustyn et al., 2021).

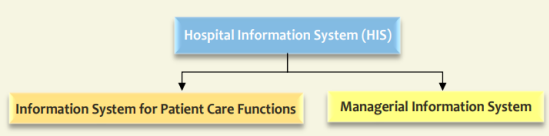

Figure 2. HIS Structure

Easy access to doctor data for the creation of various records, including classification based on demographics, gender, age, and other factors, is one advantage of having an HIS. This improves the continuity of care and is especially useful at the point of outpatient care (outpatient). Internet-based access also makes it easier to get this information from a distance, enhances patient care, and acts as a decision-support tool for hospital administrators as they create complete health care policies, accurate financial management, and dietary regimens. patients, medical procedures, and how medical aid is distributed. This makes it easier to understand the whole picture of hospital expansion, greater medication use monitoring, and

efficacy research. Hospital software is user-friendly and eliminates handwriting errors, which reduces the likelihood of harmful drug interactions while promoting more precise pharmaceutical use, improving documentation quality, enhancing information integrity, reducing transcription errors, and reducing duplication of information entry. A computer with new technology performs flawlessly while retrieving information from a server or cloud server. construction of a broad clinical database (Mehdipour & Zerehkafi, 2013).

2. Electronic Medical Record

EMRs are official patient records created digitally in healthcare facilities and other contexts. A wide range of clinical and personal data can be found in an EMR. An EMR system's specific goals are as follows: Access comprehensive patient data, track patient progress, aid in managing chronic diseases, simplify disease coding for disease billing and demographics, enhance communication between healthcare providers with easily readable information, give care staff decision support tools, create patient education materials, and keep track of medical interventions for health maintenance and prevention (Alpert, 2016).

EMR adoption has demonstrated a number of advantages for enhancing public health. For instance, there is less need for storage space, and finding patient records takes less time. An electronic search for records can be carried out on a computer in a matter of seconds as opposed to physically looking through a file of paper medical data. As a result of the simplicity with which electronic patient records may be maintained and accessed, efficiency will rise. EMR also allows for quick updates and modifications to data. More importantly, the use of electronic medical records will make it simple to enter data at the point of care for patients [8].

3. Blockchain

Blockchain is frequently associated with electronic money like bitcoin. It is a distributed database of regularly updated and validated transaction records by a vast computer network. In contrast to a single central authority like a bank, a large community manages records; no one controls them, and no one can go back and modify or remove transaction history. Information cannot be changed in the same manner as it can in conventional centralized databases due to the blockchain's inherent distributed structural attributes and peer-confirmed guarantees. In contrast to a normal centralized database, which is hosted on specific servers, the blockchain is distributed across software users. The blockchain makes it possible for anybody on the network to access the entries of other users, preventing a single central entity from capturing control of the network. The network receives every transaction and uses computer algorithms to determine if it is legitimate. Once a transaction has been confirmed, a new transaction is linked to the preceding transactions that make up the transaction chain (Sarmah, 2018).

Advantages	Challenges
Data security	High energy consumption
Lack of intermediaries in transactions	Lack of regulations on the market
Transparency and immutability	Integration and scalability issues
Fast transactions	Cultural differences
Low trading costs	Lack of technology maturity
	Limited volume and dimensions

Figure 3. Advatanges and disadvantages of blockchain

Data security (data stored in the blockchain is complete and accurate, viewable at any time, and available to authorized users; if unauthorized users try to change data in a single block, an attacker must modify the data on all the computers storing the information, simultaneously), lack of intermediaries in transactions (through the blockchain), and availability to all users simultaneously are just a few of the benefits of using blockchain technology in the financial sector as shown in Table 1. (lack of intermediaries and related fees) (Thanapal et al., 2020).

4. Smart Contract

The conditions of the agreement between the buyer and seller are written directly into the lines of code in smart contracts, which are self-executing contracts. There are distributed and decentralized blockchain networks where the code and the agreements therein are present (Ma, 2022).

Smart contracts have a number of benefits, including speed, efficiency, and accuracy because the contract is promptly carried out if the conditions are met. Smart contracts are digital and automated, so there is no paperwork to complete or time spent fixing mistakes that frequently occur when documentation is filled out manually. Smart contracts also offer the qualities of trust and transparency in that there are no third parties involved, and all participants have access to the encrypted transaction records, so there is no need to worry about data being changed for private advantage. The fact that Blockchain transaction records are encrypted and hence very hard to hack gives smart contracts another security edge. Additionally, the hacker must alter the entire chain in order to alter a single record because each record on the distributed ledger is linked to its predecessor and succeeding records. Smart contracts also have the benefit of saving money since they do away with the need for middlemen to conduct transactions and, consequently, the time and money delays that go along with them (Murray, 2022).

5. Previous Research

There are many various topic that explore about Hospital Information System risk management.

a. MedRec: Using Blockchain for Medical Data Access and Permission Management by Asaph Azaria, et. Al. revealed that large-scale data management in EMR systems may be implemented using the decentralization concepts demonstrated by the MedRec application. Using thorough records to provide auditability, interoperability, and accessibility, Azaria exemplifies a creative method to handling medical records. Medical researchers are rewarded

for designing and maintaining the system with the help of MedRec, which enables the sharing of patient data (Azaria et al., 2016).

b. Secure and Trustable Electronic Medical Records Sharing using Blockchain by Dubovitskaya, et.al. showed the blockchain technology's applications in several healthcare contexts. This journal also examines how keeping an immutable, transparent ledger that records all network activity can help to simplify and improve medical data administration. The authors then presented a framework architecture for particular demands in terms of sharing radiation oncology data and created a prototype that assures privacy, security, availability, and access control to sensitive patient data depending on the constraints associated with the healthcare environment (Dubovitskaya et al., 2017).
c. A Novel EMR Integrity Management Based on a Medical Blockchain Platform in Hospital by Lei Hang, et. al. shown that incorporating blockchain technology into healthcare research has a number of advantages, from sharing and tracking data to the transparency and privacy required for patient safety. This study goes into more detail about a novel method for creating and deploying a decentralized platform for managing EMR utilizing blockchain technology. It strives to offer patients and healthcare professionals in hospitals secure, transparent, and beneficial medical help. Utilizing the Hyperlegder Fabric, which was created from the ground up for corporate application, the medical blockchain case study has been put into practice as a proof of concept (Hang et al., 2019).

RESEARCH METHOD

1. System Design Methodology

The methodology used for this research is to use system design. This design method is used by utilizing the blockchain workflow / Blockchain Design Workflow (BDW) (Holbrook, 2020) and also using an approach using the Blockchain Ethical Design Framework – BEDF framework (Lapointe & Fishbane, 2019), with the following description:

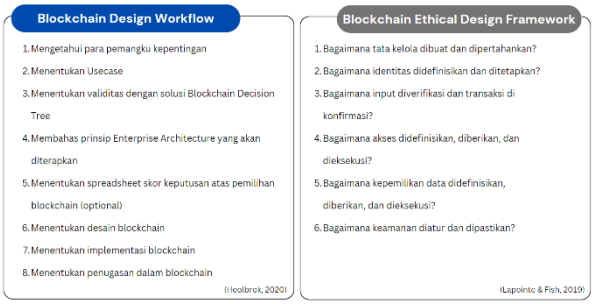

Figure 4. Workflow and Framework for developing solutions

a. From the above approach, it can be described as follows:
b. Identifying and formulating problems from stakeholders and knowing the conditions and expectations of all stakeholders involved
c. Identify uses of blockchain technology
d. Determine the boundaries and stages of the design
e. Making process flows including interactions carried out by the entities involved in it
f. Determination of governance

g. Determination of users and rules in running the process
h. Determination of transaction verification and authentication mechanisms
i. Determination of data ownership
j. Access determination
k. Determination of system security mechanisms

2. XYZ Hospitals on EMR Blockchain

A private hospital with more than 41 locations in Indonesia is called XYZ Hospitals. XYZ Hospital is currently acquiring hospitals to grow its network of hospitals.

Integration and Implementation problem on EMR

The primary issues with the challenging implementation and integration of EMR will be discussed in numerous sections, including:

a. To increase the number of its branches, XYZ Hospital continues to grow into various regional hospitals
b. Every hospital that XYZ Hospital has acquired has its own system
c. Due to the numerous gaps and lack of personnel to manage and maintain the XYZ Hospital's primary system, it is challenging to apply the XYZ Hospital
d. Because there is a lot to prepare for and it will cost more, integrating the system in one acquiring hospital also takes time and planning
e. As a result of the system's improper implementation, the patient really gets into difficulty since their EMR data is not transferred to the hospital that was acquired
f. Despite the patient claiming to have received treatment at XYZ hospital, but in a different branch, doctors struggle to diagnose and prescribe medications because they lack access to patient EMR data
g. There will be ongoing security challenges as a result of the lack of resources and various systems

One of the crucial components that XYZ Hospital need for its growing operation is information exchange. Therefore, it is necessary to pay more attention to how the XYZ hospital's system might be readily employed against their acquisition hospital. The XYZ hospital is now unable to ensure the security of data when it is transferred to the acquisition hospital because it has not discovered a platform that can integrate more readily with a high degree of security. With the transfer of information, it is believed that the blockchain-based system held by the XYZ hospital would be able to quickly replace the system at the acquisition hospital, enhancing current security and simplifying doctor-patient communication.

RESUKTS AND DISCUSSION

1. Business Requirements and Use Case Validity

Here is a more thorough mapping between business needs and the viability of use cases so that you may make conclusions and decide whether blockchain technology can satisfy the requirements for a good solution in this situation, such as:

a. Perceptions of the demands in the commercial, technical, and legal fields based on the presentation in the table below:

Criteria Analysis & Requirements					Perspective		
No	Category	Requirements	Response	Description	Business	Technical	Law
1	Distributed Ledger	There is a recorded and consistent multi-entity data sharing facility	Yes	Identification of understanding needs indicates that there is potential for the use of recording patient data in the EMR for each entity that has collaborated so that the data can be used as a reference in	Recording of diagnosis results from doctor's teleconsultation into EMR blockchain	Blockchain Application	Asset Listing
2	Smart Contract	Capabilities regarding business rules and transaction data are viewable by entities	Yes	Identification of needs shows that a contract is needed that can execute a condition automatically, and the rules apply to all entities without being able to be changed to maintain consistency.	Business deal	Application of Smart Contracts and DApp	Agreement between entities
3	Distributed	No centralized data required	Yes	Identification of needs shows that a distributed information storage mechanism is needed so that validation of the information held is always available and each entity owns the data.	Information distribution across entities	Information storage in each entity	Information records across all entities
4	Immutability	Immutable record-keeping-related capabilities	Yes	Identification of needs indicates that facilities are needed for permanent and reliable records so that each entity can be sure that the information is valid and consistent	Validity of Recorded Information	Does not allow modification of information	Trusted information

Figure 5. Critical Analysis & Requirements

b. Determination of all stakeholders

For stakeholders involved in this business process as follows:

1) Patient

When registering at XYZ Hospital, patients who serve as the facility's principal key must have an EMR. When visiting other XYZ branch hospitals, this patient wants his EMR data to be used so that patients can be safer since doctors base their diagnosis on earlier historical medical records. When entering information into the EMR, the patient acknowledged that it would be used only for medical treatment and that the information would be supplied to the doctor.

2) XYZ Hospitals

All EMR patients who have received in-patient care at XYZ Hospital are kept there in the capacity of a hospital. Doctors can utilize the EMR data as a patient history as a point of reference when making a diagnosis. Additionally, XYZ Hospital is needed to provide features that connect all hospital services in each location while maintaining quality standards and patient expectations.

3) Doctor

The doctor whose responsibility it is to review the patient's medical records in order to establish an accurate diagnosis, offer input in line with consultation observations, and reference medications in line with previously created medical records by XYZ Hospital.

4) Pharmacy

The pharmacy will place more emphasis on its role in supplying medications in response to doctor's orders and carrying out usage instructions for medications in accordance with the kind of medication.

c. Determination of the outline of the business process to be carried out

The difficulties that XYZ Hospital had while acquiring new branches or hospitals led to the first conception of the EMR Blockchain notion. Patients visiting the XYZ branch hospital expected the same level of care and the system's digitization, particularly with regard to patient data, whether these hospitals had a system before or not. Thus, to enable integration into both the old and new systems, this patient data may be uploaded via Blockchain. The EMR's patient data is computed as a transaction that has to be added to a blockchain. Therefore, the XYZ hospital will upload every patient's electronic medical record (EMR) who has received care there, and if the patient schedules an appointment at a new hospital or another branch of the XYZ hospital that has recently been acquired, data can be retrieved from the blockchain system based on its validity. the patient, in order for the matching data to be transmitted to the doctor, who will then have access to add new data in the patient's electronic medical record (EMR) and send the completed data back to the blockchain.

2. Blockchain Technology Identification Results

The methodology will make use of the Blockchain Decision Tree technique to determine whether blockchain technology can satisfy the requirements for the examples of use cases provided. If every response is "YES," blockchain technology may offer a solution that works with the use case at hand. The table below includes a description of the decision tree:

Identification	Response	Description
Does the use case used involve the utilized of a database?	Yes	Because for every transaction that occurs, space is needed to store the transaction data
Will several users update or add information?	Yes	Every authorized user can view and save diagnostic data into the patient's EMR
Does the number of users need trust between users?	Yes	Each user needs to ensure that other user entities are entities that generate usable and reliable information
Are the rules used to organize and coordinate the participants different?	Yes	The rules applied to users will differ depending on the role they have and the type of user they are
Are the records made permanent and immutable for past data?	Yes	Each user needs to ensure that the stored records are history that can be used to track for a specific purpose
Can the transaction rules not change at any time?	Yes	Every rule will relate to the contract that has been agreed upon with other stakeholders, so there needs to be a mutual agreement
Is the transaction type private?	Yes	The transaction information that applies to this case is personal, and only the related person can access the data
Are transactions related to each other?	Yes	In the context of integrating between scenarios in the business process, transactions that will be executed are related to one another

Figure 6. Blockchain System Identification

3. Boundary Provisions and Design Stages

The key platform for manufacturing this design will be the public blockchain Ethereum. The scope restrictions in the detailed design plan are as follows:

a. Identifying the specific needs and goals of the new branch hospital in terms of EMR management. This could include factors such as the type and volume of patient data that

will be stored, the number of healthcare providers who will be accessing the records, and any regulatory requirements that need to be met.

b. Selecting a suitable blockchain platform to build the EMR system on. This could involve evaluating different platforms based on factors such as security, scalability, and the ability to integrate with other healthcare systems.
c. Designing and developing the EMR system, including the user interface and any necessary integration with other hospital systems.
d. Testing and piloting the EMR system to ensure that it is functioning as intended and meets the needs of the new branch hospital.
e. Training healthcare providers and other staff on how to use the EMR system, as well as developing policies and procedures for managing and accessing patient records.
f. Deploying the EMR system in the new branch hospital and ensuring that it is properly integrated into the hospital's overall workflow.

Additionally, there are 2 key elements in this architecture that serve as the foundation for blockchain-based EMR applications, notably:

a. Ethereum Virtual Machine (EVM), which serves as a platform for smart contracts and blockchain technology
b. Decentralized application (dApp) that acts as the primary access point for actors and maintains continuous communication with applications built on blockchains as well as continuous integration and interaction with smart contracts

4. Process Flow Identification

Identification of the process flow before and the expectations after the EMR blockchain was implemented at the new XYZ branch hospital, as follows:

a. Before using EMR Blockchain:
   1) The patient may need to provide their medical history and other personal information to the hospital each time they visit.
   2) The hospital may need to manually retrieve the patient's records from a physical chart or electronic system each time they visit.
   3) The hospital may have to rely on fax, mail, or other slow or insecure methods to share the patient's records with other healthcare providers.
   4) Storing electronic records in a centralized database, which might be managed by the hospital or a third-party vendor.
   5) Providing access to medical records to authorized healthcare providers and staff through a secure login system.
   6) Managing record updates and changes manually, potentially involving multiple copies of the same record and the need to reconcile discrepancies.

b. After using EMR Blockchain:
   1) The hospital will be able to quickly and securely access the patient's records through the EMR system.
   2) The hospital will be able to share the patient's records with other healthcare providers more efficiently and securely, using the decentralized nature of the blockchain.

3) Collecting and digitizing medical records as before, but now storing them directly on the blockchain.
4) Providing secure, decentralized access to medical records through the blockchain EMR system, with access granted to authorized healthcare providers and staff through cryptographic keys.
5) Automatically updating and reconciling medical records on the blockchain as they are modified, ensuring a single, up-to-date version of each patient's medical record.
6) Leveraging the immutability and security of the blockchain to ensure the integrity and confidentiality of patient medical records.

Overall, implementing a blockchain EMR system at a new branch hospital can help to streamline and secure the process of managing and accessing patient medical records, improving the efficiency and effectiveness of healthcare delivery. Also, the implementation of an EMR system using blockchain technology may lead to more efficient and secure management of a patient's medical records, which could potentially improve the patient experience and the overall business flow of the hospital. However, it is important to note that the implementation of such a system is a complex process that requires careful planning and coordination.

5. Governance Provisions

Ethereum itself is a public, permissionless blockchain with pre-established rules and governance. There is a very high coordination barrier for making fundamental modifications, which encompasses both technical and social processes, to guarantee any changes to Ethereum are safe and secure. As a result, changing the rules of Ethereum itself is a quite lengthy process. supported by the general public.

The transparency and inclusivity of Ethereum governance procedures are sometimes sacrificed for speed and efficiency. Beacon Chain was released independently of the Ethereum network's proof of work and adheres to its own governance procedures in order to hasten the development of the platform.

Although the process for developing and implementing specifications is always entirely open source, the formal procedure for submitting modifications as detailed above is not followed. This enables researchers and implementers to specify and accept modifications more rapidly.

6. User Terms and Rules

Although the process for developing and implementing specifications is always entirely open source, the formal procedure for submitting modifications as detailed above is not followed. This enables researchers and implementers to specify and accept modifications more rapidly:

a. User

Every person using an application is engaged in continuous, silent communication with an application on the Ethereum Blockchain. For this study, consider Pasien, Pharmacy, and Doctor.

b. Application Developer

Application developers are those who design and build blockchain-based apps. For instance, acquisitions and branches for XYZ Hospital

7. Mechanism of Verification and Authentication

The verification process itself relies on the "Proof-of-work" consensus (PoW). By conforming to the status of all information stored on the Ethereum blockchain and preventing specific sorts of economic threats, this consensus enables the Ethereum network nodes. To identify the nonce of a block, miners using the PoW protocol Ethash must compete fiercely in trials. A block may only be added to the chain if it has a valid nonce. PoW does not trust any particular peer on the network; instead, it trusts the whole network as a whole. Another benefit of employing PoW for current development requirements is that expenses are decreased because tokens or coins are not required on each node.

Then, about the two-factor authentication mechanism (2FA). The security technique known as 2FA is used to confirm that users who access an account are the account's original owners. This security system needs two different kinds of authentication, as the name would imply. Threats can't access users' personal accounts by using 2FA. There are three basic categories of factors that can serve as proof of authenticity, including:

a. Something the consumer is aware of (like a password or security question)
b. Something associated with the user (for example, fingerprints or eye / face scans)
c. Something that the user owns (such as keys or authentication in mobile devices)

8. Data Ownership Requirements

Before being able to access the data that belongs to them, the owner of the data must have public keys that may serve as an authentication bridge. The public keys needed to access the different types of data, as well as the information from the data owner, might vary since it is all unique.

9. Terms of Access Rights

Determining access permissions places a greater emphasis on the user's ability to obtain and accept data. There are some data that may be accessible generally, notably data that is held in open-shared that has been intended from the start. The provisions for these access rights rely on the role that the user has. Each role also has the right to access various data freely.

10. System Security Mechanism Provisions

Since Ethereum does not need permission, Ethereum has decided how the system security method would be determined. Smart contracts can also assist in ensuring the security of application systems in the future, beginning with safeguarding patient EMR data that is transferred to the blockchain so that other stakeholders can use this data without having to consider their concerns about the security issues at the time.

CONCLUSION

An EMR blockchain design for a new hospital or branch hospital has the potential to be explored and improved in the future, according to study utilizing a combination of the Blockchain Design Workflow (BDW) methodology and the Blockchain Ethical Design Framework - BEDF framework. In order to determine whether the XYZ Hospital's system can be implemented directly in the new branch hospital's environment and whether it can be

implemented at all in the acquisition hospital, which must already have a system that behaves very differently from the XYZ Hospital's system, in-depth analysis is necessary. To close this gap and ensure that all hospitals have access to the same patient record data decentralizedly, the EMR blockchain might be offered. Data transmission with the standard system is still in doubt since there is no guarantee of the security of the data because the security of the new branch hospital and the acquired hospital cannot be guaranteed securely. The EMR blockchain can help all hospitals in the future by easing their concerns and facilitating hospital system mobilization, particularly in the patient data department.

In order for blockchain to become the most recent innovation in the healthcare industry, this research is still centered on the original concept of blockchain and depicts business processes that were present in hospitals before and after the deployment of blockchain.

DAFTAR PUSTAKA

Alpert, J. S. (2016). The electronic medical record in 2016: Advantages and disadvantages. *Digital Medicine*, *2*(2), 48.

Augustyn, D. R., Wyciślik, Ł., & Sojka, M. (2021). The Cloud-Enabled Architecture of the Clinical Data Repository in Poland. *Sustainability*, *13*(24), 14050.

Azaria, A., Ekblaw, A., Vieira, T., & Lippman, A. (2016). Medrec: Using blockchain for medical data access and permission management. *2016 2nd International Conference on Open and Big Data (OBD)*, 25–30.

Dubovitskaya, A., Xu, Z., Ryu, S., Schumacher, M., & Wang, F. (2017). Secure and trustable electronic medical records sharing using blockchain. *AMIA Annual Symposium Proceedings*, *2017*, 650.

Hang, L., Choi, E., & Kim, D.-H. (2019). A novel EMR integrity management based on a medical blockchain platform in hospital. *Electronics*, *8*(4), 467.

Hasan, A., & Mardhani, M. (2021). An overview of e-commerce adoption in Indonesian SMEs. *Journal of Physics: Conference Series*, *1811*(1), 12104.

Holbrook, J. (2020). *Architecting enterprise blockchain solutions*. John Wiley & Sons.

Lapointe, C., & Fishbane, L. (2019). The blockchain ethical design framework. *Innovations: Technology, Governance, Globalization*, *12*(3–4), 50–71.

Ma, A. (2022). What are Smart Contracts and How Do They Work? *ITNOW*, *64*(3), 50–51.

Mehdipour, Y., & Zerehkafi, H. (2013). Hospital information system (his): At a glance. *Asian Journal of Computer and Information Systems*, *1*(2).

Mubarak, M. F., & Petraite, M. (2020). Industry 4.0 technologies, digital trust and technological orientation: What matters in open innovation? *Technological Forecasting and Social Change*, *161*, 120332.

Murray, M. D. (2022). NFTs rescue resale royalties? the wonderfully complicated ability of NFT smart contracts to allow resale royalty rights. *The Wonderfully Complicated Ability of NFT Smart Contracts to Allow Resale Royalty Rights (July 15, 2022)*.

Reimers, T., Leber, F., & Lechner, U. (2019). Integration of blockchain and internet of things in a car supply chain. *2019 IEEE International Conference on Decentralized Applications and Infrastructures (DAPPCON)*, 146–151.

Sarmah, S. S. (2018). Understanding blockchain technology. *Computer Science and Engineering*, *8*(2), 23–29.

Strebinger, A., & Treiblmaier, H. (2022). Profiling early adopters of blockchain-based hotel booking applications: demographic, psychographic, and service-related factors. *Information Technology & Tourism*, *24*(1), 1–30.

Thanapal, K., Mehta, D., Mudaliar, K., & Shaikh, B. (2020). Online Payment Using Blockchain. *ITM Web of Conferences*, *32*, 3007.