EHR: Patient Electronic Health Records using Blockchain Security Framework

***Abstract*—The Hospital Management System at ERH implements advanced technological elements which optimize healthcare operations while improving patient visit quality. The system combines five distinct portals including User and Admin and Doctor and Lab and Insurance whichBLOCKCHAIN Ethereum technology and Ganache provide confidential data storage and visibility. Users obtain personalized access to the interface using OTP authentication which enables them to use a chatbot API together with appointment scheduling features and doctor feedback collection and insurance claim filing and laboratory report retrieval functions. Doctors can execute administrative tasks like appointment scheduling and patient record management and bed allocation and lab test procedure and insurance documentation through their user-friendly dashboard interface. Administrators have full field oversight of user system management with control over appointment history maintenance and doctor profiles monitoring and patient feedback collection and they track laboratory and insurance system functions. The laboratory sector obtains direct medical tests from doctors for analysis before generating fast return output. The insurance sector uses this solution to handle claims with ease by executing validifications then providing reimbursements. The solution leverages a stack that includes Python as well as Django framework alongside HTML, CSS, JavaScript and Bootstrap tools and a MySQL database for creating reliable and scalable and friendly healthcare management software.**

***Index Terms*—Hospital Management System, Blockchain Ethereum, Ganache, Python Django, Chatbot API, OTP Authentication, Lab Management, Insurance Claim, Appointment Scheduling, Healthcare Portal**

I. Introduction

As an advanced digital platform the ERH Hospital Management System provides healthcare services management by centralizing multiple systems across healthcare organizations. The management system features five different portals: User, Admin, Doctor, Lab and Insurance which specifically serve particular healthcare management functions. This system adopts Blockchain Ethereum technology from Ganache as its base to secure patient data as well as administrative content and ensure data integrity and trackability.

The User portal provides patients with an OTP verification system for secure registration as their initial step. Users who complete their registration successfully obtain a dashboard that contains all necessary features. The user interface provides a dynamic chatbot API to guarantee immediate help and lets patients book doctor visits and control their appointments while also finding a platform to submit evaluation of doctor meetings and manage insurance claims and read their laboratory results. Patients can improve healthcare results by communicating directly with their doctors through built-in chat systems in the system.

Healthcare professionals access specialized Doctor portal dashboards which suit their clinical work needs as well as administrative requirements. Through the Doctor portal healthcare staff can manage their appointments alongside maintaining complete history records and receive hospital bed availability updates and initiate laboratory test requests and consult insurance information. Doctors achieve better patient care outcomes through their access to a holistic view across all medical facilities.

Hospital administrators use their dedicated Admin portal to gain full visibility into every hospital management operation. The Admin portal allows users full supervision of hospital management activities through its complete set of administrative controls which include managing users and maintaining doctor profiles and patient appointment management alongside feedback review and laboratory request tracking and insurance claim tracking. The central control system by administrators leads to functional operations and effective hospital resource management.

Through Lab portal laboratories can handle all their procedures with efficiency and speed. Laboratories complete medical assessments after doctors send multiple test requests by returning results directly to doctors. The process works efficiently for physicians to obtain full reports. The combined workflow system decreases appointment durations and speeds up healthcare choices in medical facilities.

Through the Insurance portal providers gain the power to handle insurance claims effectively for swift processing. Insurance personnel review claims before they authorize payments through a system that speeds up the process for releasing claim amounts. The portal creates a streamlined process that fastens reimbursement activities for medical institutions alongside patients.

The ERH Hospital Management System uses Python and Django framework to develop its reliable backend capabilities. Bootstrap joins HTML CSS and JavaScript along with Bootstrap to deliver a user-friendly frontend presentation. The MySQL database offers advanced capabilities to manage healthcare data which ensure both reliability and scalability needed to manage substantial healthcare information. The combination of Ganache within Blockchain Ethereum and the health management system utilizes Ethereum technology to address present healthcare needs by offering hospital-specific solutions with secure management and transparent operation.

II. Literature Survey

Hospital management systems through digitization have experienced significant advancements because they serve as an essential component for organizations that want to enhance their operational performance and patient experience and administrative efficiency. The successful operation of hospitals depends on various critical operational components which fuse together patient enrollment with physician and patient relations as well as diagnosis times and laboratory functions alongside healthcare insurance processes and system security systems. The transfer from traditional hand-based hospital systems to automated systems shows two principal benefits: it speeds up administrative work and it produces superior medical care through efficient healthcare information distribution [1].

Healthcare management has recently adopted blockchain technology as its essential innovation through distributed data storage and enhanced security and complete transparency capabilities. Thanks to its unalterable nature Blockchain prevents unauthorized edits to data and enables safe transaction tracking which limits fraudulent activities and data tampering. Smart contracts on Ethereum blockchain ensure automated data handling between healthcare partners through secure data exchanges to support complex healthcare activities such as electronic medical records (EMRs) and patient consent management and insurance claims processing [2]. Local Ethereum blockchain solution Ganache provides developers with an efficient environment simulation platform to accelerate secure healthcare solution testing and prototyping [3].

Integrating chatbots into healthcare structures yields important advantages regarding user involvement along with better patient experiences while simultaneously lowering healthcare personnel's operational tasks. AI-powered chatbots provide medical institutions a solution to manage basic patient inquiries and scheduling appointments and delivering medication reminders and screening patients and insurance inquires thereby freeing up healthcare staff for essential medical work [4]. The research conducted by Nadarzynski et al. demonstrates that patients achieve higher satisfaction when interacting with chatbots because their system provides immediate support during all hours which enhances the delivery of healthcare services [5].

Secure patient data protection now requires the use of strong authentication systems through One-Time Password (OTP) mechanisms as the basic safeguard. OTP authentication shields healthcare facilities from cybersecurity threats because it delivers secure one-time authentication during sessions which diminishes both unauthorized data entry and security attacks. Research by Bhargav-Spantzel et al demonstrates that OTP-based systems secure patient data better than traditional static passwords according to their findings that were published in [6].

Messenger Healthcare chooses backend technologies based on Python which uses Django web framework because they offer solutions that deliver convenient development alongside strong scalability and secure protection. Django establishes a systematic framework to develop web applications quickly while executing database operations together with user authentication features along with session management and API integration tools which make hospital management systems fully operational [7]. Healthcare applications use MySQL database systems because these solutions provide dependable data management together with efficient query processing and adaptable handling of large healthcare databases [8].

HTML, CSS, JavaScript together with Bootstrap framework enable the development of frontend components which produce accessible user interfaces that respond to different devices. A responsive design provided by Bootstrap helps developers build accessible user-friendly web applications that work across different devices with multiple display sizes which leads to enhanced customer experiences [9]. The report by Frain establishes user-centered design frameworks improve healthcare applications while they enhance user engagement and satisfaction along with accessibility features [10].

By digitizing testing procedures in healthcare labs laboratories attain speedier results delivery which advances the efficiency of patient medical treatment. Automated laboratory information systems provide accurate and timely diagnostic result delivery through their secure mechanism which allows clinicians to make better decisions promptly [11]. The research conducted by Georgiou et al. demonstrates that digital laboratory information systems play an essential role in lowering clinical mistakes and administrative work and test result wait times to create more effective health services [12].

Hospital systems through their insurance management portal execute complex claims-processing tasks which enhances both accuracy and efficiency while it reduces patient administrative burden thus improving satisfaction. Message management technology processing digital insurance claims improves speed and efficiency of payment transactions as well as data processing time [13]. Digital insurance systems demonstrate their effectiveness in shortening claim durations and boosting patient satisfaction by using transparent features as per Wilson et al.'s research [14].

The analysis of existing research establishes that applying blockchain technology with chatbot features and authentication protocols and applying backend and frontend systems brings substantial advantages to hospital management systems. Medical technology progression ensure the improvement of healthcare administration performance while enhancing patient satisfaction and protection along with delivering superior service quality.

III. Methodology

A. Proposed System

The proposed ERH Hospital Management System implements an extensive integrated platform that optimizes healthcare operation management through efficient methods. The system features five distinctive portals which include User and Admin and Doctor and Lab and Insurance. The system leverages Blockchain Ethereum through Ganache to deliver better security alongside clearer operations alongside more

dependable data integrity. The system's core objectives focus on delivering improved medical interactions for patients and doctors as well as streamlining appointment bookings and reinforcing lab systems and accelerating insurance claims processing and enabling safe user access through OTP authentication techniques.

B. Methods in Proposed System

Various essential methodologies form the basis of the proposed system which delivers its intended functions.

A system relies on OTP authentication to create secure user login procedures.Integration of Chatbot API for real-time patient assistance. The system implements Ethereum and Ganache for Ethereum blockchain to secure while enhancing data transparency. Centralized appointment scheduling and patient-doctor communication. Real-time laboratory report handling and secure communication between Lab and Doctor portals. Digital management and validation of insurance claims.

C. Detailed Methodology

The decision flow at ERH Hospital Management System embraces Python programming and Django web framework together with MySQL database and frontend components that consist of HTML, CSS, JavaScript and Bootstrap. The system uses Blockchain Ethereum technology as a way to bolster its secure data handling capabilities.

The User portal starts by allowing patients to register with secure One-Time Password (OTP) authentication for verified access protection. After authentication through registration users receive a customized interface that combines chatbot capabilities and appointment booking as well as doctor feedback submission and insurance services and laboratory report retrieval and real-time patient-doctor messaging.

Healthcare professionals use the Doctor portal to access a dashboard enabling them to schedule patient visits while reviewing appointment records and hospital bed usage status and laboratory testing initiation and insurance claim record examination capabilities. Through the lab portal doctors can quickly order diagnostic exams which results are sent quickly to enable them to make better clinical choices.

Through the Admin portal administrators control access to the system by managing accounts for all users and maintaining doctor profiles while managing appointments and their histories as well as handling user feedback and monitoring laboratory requests and insurance claim procedures.

All laboratory personnel use the Lab portal to gather test requests directly from doctors and then complete diagnostic procedures before transmitting results to doctors quickly. This enhanced communication system leads to rapid response times that improve the deliverance of quality patient care.

Through the Insurance portal insurance staff can digitally review validate and approve claims which results in faster payments and better patient satisfaction.

The implementation of Blockchain Ethereum through Ganache enables secure and trackable system operations for appointments and insurance claims and laboratory tests. Every change entering the blockchain ledger maintains its permanent status which creates both transparency and protected information for the system.

Mathematically the generalized blockchain transaction algorithm of the system operates as follows: beginequation $\mathrm{T}_x = H(T_{x-1}, D_x, TS, S)(0)$

Where:

T_x represents the hash of the current transaction block, T_{x-1} is the hash of the previous block, D_x denotes current transaction data (appointments, lab results, insurance claims), TS symbolizes the transaction timestamp, and S is the digital signature of the initiator. This algorithm ensures each data entry is securely chained and verifiable, protecting system integrity and facilitating auditability.

The architectural overview of the ERH Hospital Management System is illustrated in Figure 1, highlighting interactions among User, Doctor, Admin, Lab, and Insurance portals, blockchain network, and database management components.

system_architecture.png

Fig. 1. System Architecture of ERH Hospital Management System

The data flow within the system is depicted in Figure 2, clearly demonstrating secure data movement across various portals facilitated by blockchain Ethereum integration, ensuring reliable and transparent data communication among stakeholders.

Through this robust methodological framework, the ERH Hospital Management System effectively addresses the complexities inherent in hospital management, ensuring efficiency, security, and high-quality healthcare services.

IV. Implementation

A. User Portal Implementation

Secure user authentication starts through One-Time Password (OTP) verification for registration steps at the begin-

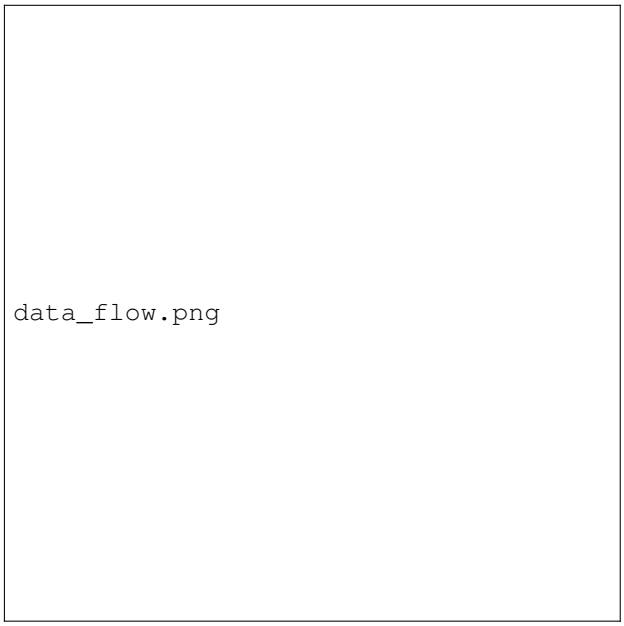

Fig. 2. Data Flow Diagram of ERH Hospital Management System

ning of User portal implementation. User interfaces following authentication present an easy-to-use dashboard that enables them to interact with both an AI-powered chatbot for instant queries and a tool to book appointments with available physicians as well as to submit feedback and start and track insurance claims alongside the retrieval of lab results and the ability to directly message doctors through the system.

B. Doctor Portal Implementation

The Doctor portal features an optimized dashboard which supports doctors to handle incoming appointments efficiently and keeps detailed appointment records and shows current hospital bed counts while allowing lab test requests and offering access to claim history information. A unified framework increases both patient-doctor dialogue quality together with quick clinical assessment processes.

C. Admin Portal Implementation

The implementation features of the Admin portal enabled centralized control for administrative tasks. Through this portal administrators handle user sign-ups while also maintaining doctor roster updates and appointment records and reading patient feedback and handling all activities between the laboratory and insurance services. The portal operates as a centralizedmodifiable interface that grants administrators full management capacity to maintain system operations.

D. Lab Portal Implementation

The primary purpose of the Lab portal involved providing capabilities for laboratory personnel to successfully handle doctor-initiated test requests. The system provides functionality that allows digital receipt of test requests from doctors alongside necessary lab procedure execution and report preparation before secure result distribution to doctors. By simplifying the process clinical diagnostics attains better operational efficiency and precision.

E. Insurance Portal Implementation

The Insurance portal implementation aimed at simplifying and accelerating claim management processes. Insurance staff can digitally verify submitted insurance claims, validate the associated documents, and swiftly approve or reject claims. This approach significantly improves claim-processing efficiency, reducing administrative workload and enhancing patient satisfaction through timely reimbursements.

F. Blockchain Ethereum Integration

Blockchain Ethereum technology was integrated using Ganache to ensure secure, decentralized, and tamper-proof storage of all critical healthcare-related data, including appointments, medical reports, insurance claims, and transaction records. Each transaction is recorded securely onto the blockchain ledger, guaranteeing data transparency, security, and auditability across the entire system.

G. Backend and Database Implementation

Backend functionalities were implemented using Python programming integrated with Django, providing robust security, efficient database interactions, and seamless API integration. MySQL database was chosen for its reliable data management capabilities, scalability, and ease of handling complex healthcare data operations.

H. Frontend Implementation

The frontend user interface was developed using HTML, CSS, JavaScript, and the Bootstrap framework to ensure a responsive, intuitive, and user-friendly experience across various devices and screen sizes. The implementation focuses on ease-of-use and accessibility, contributing to improved user engagement.

I. Implemented System Interfaces

The implemented User Insurance interface showcasing various integrated features is illustrated in Figure 3.

A detailed implementation of the ERH Hospital Management System creates an advanced secure and efficient solution for current healthcare management standards which results in improved service quality and patient satisfaction.

V. Result and Discussion

The ERH Hospital Management System together with its Chatbot functionality reaches a successful conclusion after development and implementation through five interconnected portals: User, Admin, Doctor, Lab, and Insurance. Hospitals achieve enhanced data security and strengthen their operations with Blockchain Ethereum through Ganache implementation which also promotes high scalability transparency and reliability.

Fig. 3. User Insurance Interface

Users experience reliable security features because they can perform OTP-authenticated registrations and logins on the User portal. New security measures through this feature lowered the chances of unauthorized access and protected user data. The built-in chatbot system provided immediate assistance to patients while ensuring their constant support which significantly enhanced their patient experience. The healthcare system became more efficient through appointment bookings and doctor feedback submissions and insurance claim management and quick test report availability.

Through the Doctor portal medical staff successfully managed their patient appointment schedules effectively. Medical staff gained full access to extensive patient records and could check immediate bed capacity and launch laboratory test orders as well as review insurance documentation effortlessly. The electronic integration resulted in improved patient care through expedited clinical choices and better quality doctor and patient interactions.

The development of the Admin portal brought remarkable improvements in administrative management procedures. The implementation made it easier to manage users and doctors as well as appointments through automated scheduling and real-time monitoring and it provided effective oversight of laboratory and insurance portal management. The combination of these features operated to improve hospital operations and maximize therapeutic resource use.

The Lab portal enhanced laboratory operations by digital testing procedures which accepted test orders and executed diagnostics decisions and provided fast results delivery to medical staff. The optimized process streamlined clinical diagnosis procedures thus enabling healthcare providers to deliver faster patient services.

Insurance portal digitalization brought about reduced times for insurance claim processing. Insurance claim reimbursements became faster while transparency grew better together with enhanced patient satisfaction from shortened administrative delays through digital verification procedures for insurance claims.

The implementation of Blockchain Ethereum in this project requires analysis of its essential parameters which are scalability and security. The blockchain system delivered impressive scalability through its ability to manage numerous concurrent portal transactions without affecting system speed or performance. The distributed architecture efficiently distributed system load which enabled easy scalability and future-proof integration of new modules.

The security measures built into blockchain enabled comprehensive data protection through data tamper-resistant features that tracked every transaction. The unalterable data features of Ethereum blockchain delivered unmatched protection to all sensitive healthcare information including patient records together with insurance claims and appointments along with laboratory reports. The OTP authentication system enhanced overall security by minimizing vulnerabilities that might affect user login and registration procedures.

The performance evaluation of the system included analyzing positive and negative scenarios directly associated with insurance claim management. The digital insurance claim validation system operated smoothly when users submitted correct documentation coupled with policy qualifications as it followed system parameters for proper submission. Claims got rejected through negative scenarios because the policyholder failed to meet specific requirements such as missing documentation or having outdated insurance coverage or being ineligible for coverage. The scenarios illustrated both high transparency and exact processing of claims together with instant accurate feedback about the claim status.

The ERH Hospital Management System delivered its functions with enhanced administrative efficiency and security along with superior user satisfaction and transparency to establish itself as an effective reliable solution for contemporary healthcare management systems.

VI. Conclusion and Future Work

The integrated Chatbot of ERH Hospital Management System successfully managed healthcare operations through systemic connectivity of User and Admin and Doctor and Lab and Insurance portals. Healthcare data management obtained enhanced security security and scalability along with improved transparency when Blockchain Ethereum technology from Ganache was implemented. Secure OTP-based authentication combined with convenient appointment scheduling, effective chatbot assistance and simplified insurance claim processes and rapid access to laboratory reports provided benefits to users.

The medical staff distributed their resources efficiently for record keeping alongside appointment bookings and test requests to create better clinical judgment abilities. The hospital

received comprehensive administrative control through the Admin portal to ensure effective resource management together with better patient satisfaction. The combination of efficient laboratory workflow management with digital insurance claim processing lowered administrative burdens thus increasing operational success.

The ERH Hospital Management System may benefit from future development through machine learning algorithm implementation to better forecast patient admissions while optimizing resource distributions across the hospital. User interface improvements achieved through natural language processing methods will make chatbot systems more effective in their interactions. Healthcare facilities should consider putting IoT-based patient-monitoring systems into practice for providing more timely healthcare management. Continuous improvements of the system will result in better performance and patient satisfaction and enhanced healthcare quality levels.

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