ISSN 2319-5991 www.ijerst.com
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Peer Reviewed, Referred & Indexed Journal

Research Paper

BLOCK CHAIN-ENABLED HEALTHCARE: ENSURING SECURE AND SCALABLE DATA WITH MYSQL INTEGRATION

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ABSTRACT— This paper introduces MBHA (MySQL-Block chain Healthcare Architecture), a novel and efficient solution to the challenges of modern healthcare data management by integrating the structured querying capabilities of MySQL with the security and immutability of block chain technology. The architecture ensures secure, scalable, and tamper-proof storage and access to sensitive medical data, addressing concerns around integrity, privacy, and real-time collaboration. Performance evaluations demonstrate the system's effectiveness, with an average user registration response time of 1.54 seconds, login time of 841 milliseconds, database query latency under 1 millisecond, and JWT-based authentication token generation in under 50 milliseconds. The model not only supports reliable and secure operations but also aligns with regulatory compliance and scalability requirements, offering a practical framework for future-ready, secure healthcare systems. Additionally, MBHA enhances data accessibility for authorized healthcare professionals while ensuring auditability through block chain's immutable ledger. The combination of MySQL and block chain allows for efficient data indexing, fast retrieval, and traceable updates without compromising security.

Index Terms – Blockchain, Healthcare Security, MySQL, Electronic Health Records, Data Privacy, Secure Data Storage, Scalability, Smart Contracts, Access Control, Healthcare Information Systems.

I. INTRODUCTION

Data is a significant asset in the digital age, with different forms of data having distinct meanings. Healthcare data is especially valuable, yet cyber-attacks are targeting it to reap financial rewards. Data integrity security is critical because attackers utilize compromised data to execute subsequent assaults. Countries are digitizing to enhance customer experience and minimize infrastructure requirements. For example, security professionals are under threats of breaches of confidentiality, violation of privacy, and credibility breaches. Parallelly, digitization of healthcare systems has brought along revolutionary progress. The conventional healthcare systems are unable to fulfill the various needs of the patients, and inefficiencies crop up and suboptimal results occur. Instead, ML presents a paradigm shift in terms of individualized and data-driven care. Using patient data collected by advanced medical devices, predictive models developed by ML can drastically improve disease prediction and resource management. The application of AI-based medicine, especially in cancer treatment, demonstrates the scope for customized treatment plans, real-time monitoring, and holistic treatment. These changes together reflect a revolution in traditional healthcare systems toward efficiency, adaptability, and better patient care. It opened up product innovation into convergence because it bases decisions on real evidence and caters towards personalized solutions for patient care. Thousands of structured as well as unstructured data can give an insight into the diseases, progress of the treatment, and preferences of the patients, hence enabling maximum personalization through preventive measures, predictive analysis, and machine learning in terms of finding susceptible groups and also optimizing the usage of resources. However, very important challenges include data privacy, security, and regulatory compliance. To support this, a robust strategy for privacy-preserving data sharing is SMC, aligned with HIPAA and GDPR. SMC will ensure secure collaboration while protecting sensitive healthcare data and empowering patients for better healthcare outcomes. With increasing needs in effective monitoring healthcare systems, Ramani et al proposed a scheme for

optimized data management and secured federated learning named ODMSM-FL based on block chain, thereby securely managing the data on decentralized IoMT systems and effectively managing problems concerning the performance metric and administrative data security issues with data privacy. Similarly, Chen et al (2024) in introduced Mobile AI-Generated Content (AIGC) to power Human Digital Twins (HDT), leveraging rare disease data modelling for tailored medication and virtual therapy platforms to enable personalized healthcare. This is innovative and transformative in transforming patients into the frontiers of healthcare solutions. Global acceptance and development of TCM (Traditional Chinese Medicine) is challenged by its growing safety concerns, such as unexpected toxicity issues including liver and kidney injuries. The approach in a "New Outlook on TCM Safety" has been emphasized in modernized approaches to toxicity evaluation, proactive risk management, and safety strategies. Unlike existing systems that rely solely on centralized SQL databases or off-the-shelf API integrations, the proposed MBHA (MySQL-Block chain Healthcare Architecture) introduces a novel hybrid approach that ensures end-to-end data integrity through decentralized logging while retaining the performance benefits of structured SQL querying. The unique contribution lies in seamlessly embedding block chain-backed validation into traditional SQL workflows, which is further enhanced by JWT-based stateless authentication for distributed healthcare platforms. This addresses real-world limitations of siloed data systems by enabling tamper-resistant, traceable interactions across stakeholders – a feature largely missing in existing healthcare frameworks. The proposed paper, therefore, integrates MySQL with block chain technology, where MySQL's excellent querying ability is combined with the benefits of a decentralized, highly secure architecture based on block chain. The integration seeks to overcome present constraints while further strengthening data security, integrity, and accessibility within the healthcare system. The paper will explore the challenges faced by traditional systems, the conceptual framework for MySQL and block chain integration, and the methodologies used to implement the system. Through case studies and results, the paper will demonstrate the effectiveness of the proposed solution in real-world healthcare scenarios. Finally, it will discuss the broader implications of this integration, compare it

with existing technologies, and highlight future research directions.

II. RELATED WORK

A. Revolutionizing healthcare: the role of machine learning in the health sector

The project "Revolutionizing Healthcare: The Role of Machine Learning in the Health Sector" focuses on transforming traditional healthcare systems into intelligent, data-driven ecosystems through the integration of Machine Learning (ML) technologies. The project aims to utilize vast amounts of structured and unstructured healthcare data—such as patient records, medical imaging, genomic data, and sensor data from IoT devices—to enable predictive diagnosis, personalized treatment, and efficient resource management. ML algorithms are employed to detect diseases at early stages, analyse medical images, and forecast patient health risks based on historical patterns. The system also enhances clinical decision-making by providing doctors with data-backed insights and automated diagnostic suggestions. It emphasizes data privacy, ethical AI usage, and compliance with healthcare regulations like HIPAA and GDPR. Furthermore, the project promotes real-time monitoring through wearable devices and remote healthcare systems, allowing continuous tracking of patients' health conditions. By leveraging deep learning, natural language processing, and predictive analytics, it enables faster, more accurate healthcare delivery. The project also aims to reduce healthcare costs, minimize diagnostic errors, and improve overall patient outcomes. Ultimately, it envisions a smart healthcare ecosystem where technology and human expertise collaborate to ensure proactive, personalized, and high-quality medical care.

B. Artificial intelligence (AI)-enabled technology in medicine-advancing holistic healthcare monitoring and control systems.

The project "Artificial Intelligence (AI)-Enabled Technology in Medicine: Advancing Holistic Healthcare Monitoring and Control Systems" focuses on integrating AI-driven solutions to create a comprehensive, intelligent, and proactive healthcare environment. It aims to revolutionize patient monitoring, diagnosis, and treatment by leveraging AI algorithms, sensor networks, and real-time data analytics. Through continuous data collection from wearable devices, medical sensors, and IoT-enabled platforms, the system enables real-time health tracking and early anomaly detection. AI models analyse patient vitals and medical histories to predict potential

health risks and recommend personalized interventions. The project ensures remote healthcare accessibility, allowing doctors to monitor patients and adjust treatments even from distant locations. It emphasizes automation in medical decision-making, reducing human error and enhancing precision in diagnosis and treatment. Furthermore, it promotes data interoperability and integration across healthcare systems for unified patient insights. Strong data security and privacy mechanisms are implemented to comply with medical standards like HIPAA and GDPR. The project also supports AI-assisted surgeries, drug discovery, and robotic healthcare management. By combining advanced analytics with continuous monitoring, it enables a preventive and patient-centered approach. Ultimately, the system aims to build a smart, connected, and adaptive healthcare framework that ensures timely care, improved outcomes, and sustainable healthcare delivery.

C. The impact of big data on healthcare product development: A theoretical and analytical review.

The project "The Impact of Big Data on Healthcare Product Development: A Theoretical and Analytical Review" explores how big data technologies are transforming the way healthcare products are designed, tested, and delivered. It focuses on analysing massive healthcare datasets collected from clinical trials, electronic health records, wearable devices, and biomedical research to drive innovation and evidence-based product development. The project examines how big data analytics helps in identifying disease patterns, optimizing drug formulations, and predicting patient responses to new treatments. It emphasizes the use of machine learning and data mining techniques to extract meaningful insights from complex medical data. The study highlights the role of predictive modelling and real-time analytics in reducing development time and improving product efficiency. It also evaluates how data-driven decision-making enhances the safety, quality, and market readiness of healthcare products. Special attention is given to challenges such as data privacy, interoperability, and compliance with regulations like HIPAA and GDPR. The project proposes frameworks to ensure secure data sharing and collaborative innovation between research institutions and pharmaceutical companies. Moreover, it explores how big data supports personalized medicine and patient-centric healthcare solutions. Ultimately, the project demonstrates that big data serves as a catalyst

for faster, smarter, and more effective healthcare product development, shaping the future of medical innovation.

III. PROPOSED METHODOLOGY

The proposed system introduces MBHA (MySQL-Block chain Healthcare Architecture), which integrates the structured querying power of MySQL with the decentralized and tamper-resistant features of block chain technology. This hybrid model addresses the limitations of centralized systems by providing a secure, auditable, and real-time environment for managing healthcare data. User operations such as registration, login, and data insertion are handled swiftly using optimized APIs, while JWT (JSON Web Tokens) ensure robust user authentication. The block chain layer enhances data integrity by preventing unauthorized modifications and offering immutable storage, making the architecture both scalable and regulatory-compliant.

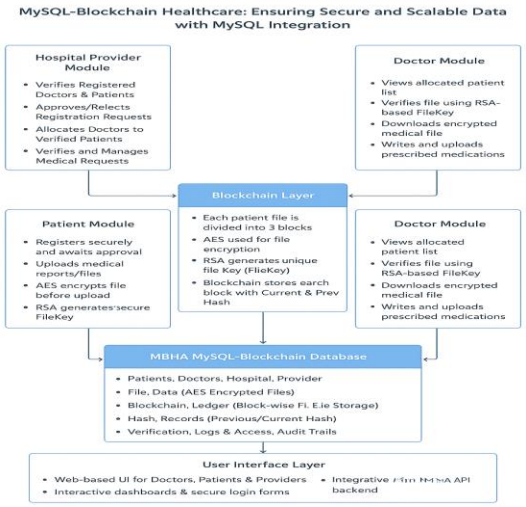
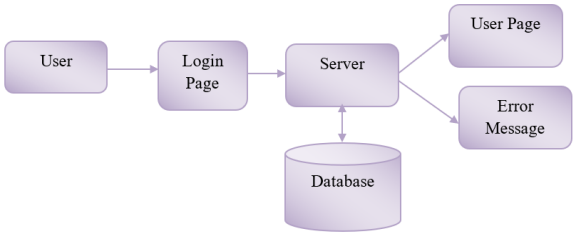


Fig. 1: System Overview

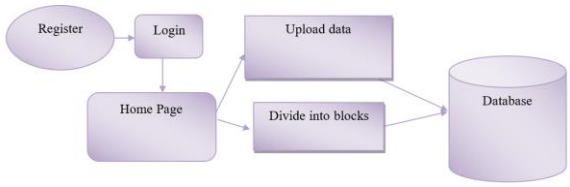
3.1 User Interface Design

To connect with server user must give their username and password then only they can able to connect the server. If the user already exits directly can login into the server else user must register their details such as username, password, Email id, City and Country into the server. Database will create the account for the entire user to maintain upload and download rate. Name will be set as user id. Logging in is usually used to enter a specific page. It will search the query and display the query.



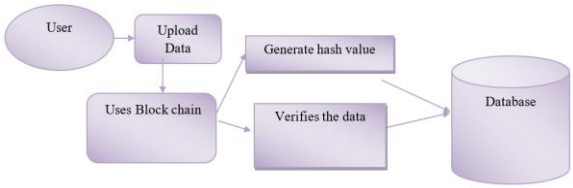
3.2 Blockchain

The Block chain module serves as the core structural and security backbone of the project. It manages the distributed ledger system, where all medical transactions—file uploads, report transfers, and approvals—are stored across multiple nodes to prevent a single point of failure. Each block contains encrypted file data, hash values, timestamps, and digital signatures, linked securely through previous and current hashes. This decentralized approach ensures data immutability, traceability, and fault tolerance. It also supports multi-party collaboration between doctors, patients, labs, and administrators, providing a transparent audit trail for every action performed. The block chain module thus guarantees trust and reliability, establishing a tamper-resistant healthcare infrastructure.



3.3 MBHA MySQL-Block chain Healthcare Architecture

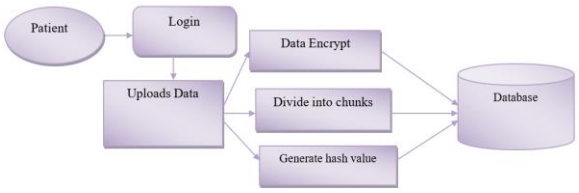
The MBHA – MySQL Block chain Healthcare Architecture combines relational database efficiency (MySQL) with the decentralized security of block chain to create a hybrid healthcare management framework. MySQL efficiently stores structured medical data like user details, registration info, and verification statuses, while block chain maintains immutable records of encrypted file blocks, hash chains, and verification logs. Together, MBHA supports scalable, secure, and verifiable medical data management, enabling both flexibility in data storage and transparency in transaction logging. This hybrid design ensures that healthcare information remains private, authentic, and traceable across all system modules.



3.4 AES

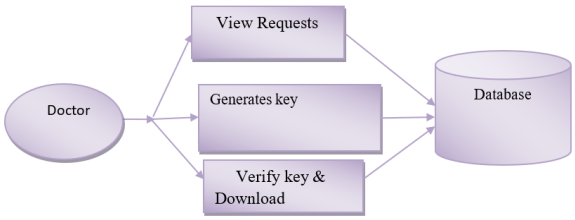
The AES module is used for encrypting patients' medical files before they are uploaded to the system. AES provides fast and strong symmetric encryption, ensuring that sensitive medical data remains unreadable to unauthorized users. It is highly efficient for large data encryption, which makes it suitable for securing healthcare files, reports, and diagnostic data. In this project, AES ensures that even if files are intercepted or stored in shared databases, they remain

protected and confidential. It forms the first layer of security in the data protection pipeline.



3.5 RSA

The RSA module is integrated for key management and secure key exchange. Since AES uses a single symmetric key for encryption and decryption, RSA is used to encrypt that AES key (file key) using an asymmetric key pair — a public and private key. This ensures that only authorized entities with the correct private key can access the decryption key, adding an extra layer of protection. In this way, RSA complements AES by managing key confidentiality and ensuring secure communication between patient, doctor, and hospital provider.



3.6 JSP Dashboard

Displays the uploaded encrypted data along with file details and timestamps. It also shows the transaction status, verification results, pending registration details, and overall project modules. The dashboard acts as the user interface for monitoring stored data, status, and user details etc….

3.7 MySQL Database

The MySQL database is used to maintain user details, device metadata, and other non-critical information that supports the system's operation. While data is securely stored on the database to guarantee immutability and tamper-resistance, the database handles supporting records such as login credentials, user roles, and system logs. This hybrid storage approach ensures both efficient system performance and strong data security by separating critical data from auxiliary information.

IV. EXPERIMENTAL RESULTS AND ANALYSIS

Experimental results showed that the integration of Blockchain Technology with MySQL provided secure and tamper-resistant storage of healthcare records while ensuring fast access to patient data. The system successfully maintained data integrity, prevented unauthorized modifications, and supported scalable handling of large volumes of medical

information. The analysis demonstrates that the proposed framework achieves a balance between security, performance, and scalability.



Fig. 2: Home Page



Fig. 3: Doctor Registration

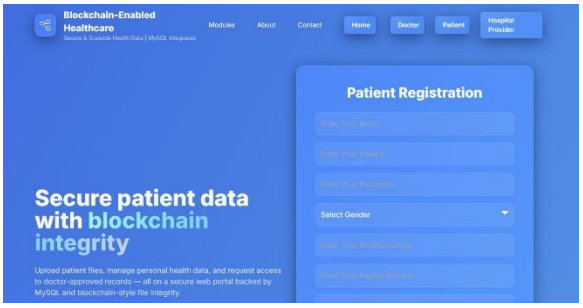


Fig. 4: Patient Registration

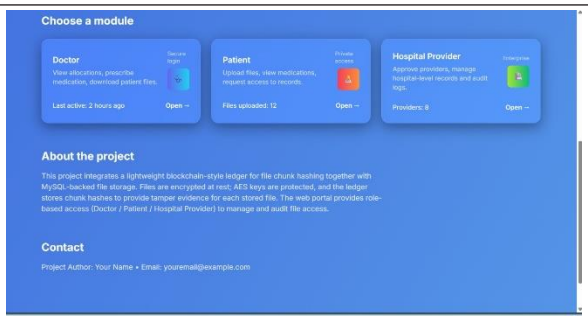


Fig. 5: Choose Module

V. CONCLUSION

The proposed Block chain-Enabled Healthcare system integrated with MySQL successfully establishes a secure, transparent, and scalable environment for healthcare data management. By combining the immutability of block chain with the structured querying capabilities of MySQL, the system ensures that medical records remain tamper-proof while still being easily accessible to authorized users. The use of AES and RSA encryption algorithms strengthens data confidentiality and authentication. Through the integration of block chain-ledgers, every medical transaction is traceable and verifiable, enhancing data integrity and trust among doctors, patients, and hospital providers. The modular design, including verification, allocation, and secure file management, simplifies the healthcare workflow. This hybrid architecture demonstrates the ability to overcome traditional database limitations by offering

both decentralization and efficient query handling. The project's performance analysis further validates its reliability with minimal latency and high throughput. Overall, the project provides a robust and scalable foundation for secure medical data management, paving the way toward intelligent, connected, and block chain-driven healthcare ecosystems.

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