|| Volume 2 || Issue 08|| 2017 || ISO 3297:2007 Certified ISSN (Online) 2456-3293

OPEN ACCESS INTERNATIONAL JOURNAL OF SCIENCE & ENGINEERING

Blockchain-Based Secure Electronic Health Record Management: Design and Performance Analysis

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Abstract: Electronic Health Records (EHRs) have become a fundamental component of modern healthcare systems by enabling efficient storage, management, and sharing of patient information across healthcare institutions. The rapid adoption of cloud computing has significantly improved the accessibility, scalability, and availability of EHR systems while introducing critical challenges related to data confidentiality, privacy preservation, authentication, access control, and secure information sharing. This experimental study proposes a secure cloud-based Electronic Health Record Management framework that integrates cloud computing technologies with encryption, authentication mechanisms, role-based access control, and secure communication protocols to enhance healthcare information security and system performance. The proposed framework incorporates healthcare data preprocessing, secure cloud storage, user authentication, encrypted data transmission, access control management, and performance evaluation into a unified computational architecture. A mathematical framework and algorithmic strategy are developed to evaluate data security, resource utilization, response time, system reliability, and Quality of Service (QoS). Experimental evaluation demonstrates that cloud-based secure EHR management significantly improves information confidentiality, authentication accuracy, healthcare data availability, communication reliability, and computational efficiency while reducing unauthorized access and operational overhead. The proposed framework provides valuable guidance for researchers, healthcare organizations, cloud service providers, and healthcare information system developers seeking to design secure, scalable, and reliable cloud-based electronic health record management systems.

Keywords: Electronic Health Records, Cloud Computing, Healthcare Information Security, Secure Data Sharing, Access Control.

I. Introduction

The healthcare industry has undergone a significant digital transformation through the widespread adoption of Electronic Health Records (EHRs), cloud computing technologies, telemedicine systems, mobile healthcare applications, and healthcare information systems. Traditionally, patient medical records were maintained using paper-based documentation, making healthcare information management time-consuming, error-prone, and difficult to share among healthcare providers. The introduction of Electronic Health Records has revolutionized healthcare information management by enabling the digital storage, retrieval, modification, and exchange of patient information across hospitals, clinics, laboratories, pharmacies, and healthcare organizations. Electronic Health Records improve healthcare efficiency by providing healthcare professionals with timely access to accurate patient information, thereby supporting faster diagnosis, better treatment planning, improved clinical decision-making, and enhanced continuity of patient care.

The rapid growth of healthcare information has significantly increased the volume of digital medical data generated every day. Modern healthcare institutions continuously produce large quantities of electronic information through laboratory information systems, radiology departments, diagnostic imaging equipment, wearable healthcare devices, pharmacy management systems, patient monitoring systems, and electronic prescription services. These digital healthcare datasets include demographic information, clinical histories, laboratory reports, diagnostic images, medication records, physiological measurements, surgical histories, allergy information, and physician observations. Managing such enormous amounts of healthcare information using conventional hospital information systems has become increasingly difficult because traditional infrastructures often suffer from limited storage capacity, poor scalability, high maintenance costs, restricted accessibility, and inadequate disaster recovery capabilities.

Cloud computing has emerged as one of the most promising technologies for addressing these limitations by providing scalable, flexible, and cost-effective computing resources over the Internet. Through virtualization and distributed computing infrastructures, cloud computing enables healthcare organizations to store and process Electronic Health Records without maintaining expensive local computing infrastructures. Cloud service providers offer virtually unlimited computational resources, distributed storage systems, automatic backup facilities, and elastic resource allocation, allowing healthcare organizations to manage continuously growing medical datasets efficiently. Furthermore, cloud computing facilitates collaborative healthcare by enabling authorized physicians, specialists, hospitals, diagnostic laboratories, pharmacies, and emergency healthcare providers to securely access patient information regardless of geographical location.

Despite these advantages, cloud-based Electronic Health Record management introduces several important security and privacy challenges. Healthcare information is highly sensitive because it contains confidential patient details including medical histories, diagnostic reports, laboratory results, prescriptions, genetic information, insurance records, and personal identification data. Unauthorized disclosure or modification of such information may compromise patient privacy, reduce trust in healthcare systems, violate regulatory requirements, and potentially endanger patient safety. Consequently, maintaining confidentiality, integrity, availability, authentication, and secure access to Electronic Health Records has become one of the most critical objectives in cloud-based healthcare information management.

Information security within Electronic Health Record systems depends upon several fundamental mechanisms including encryption, authentication, authorization, secure communication, role-based access control, and audit management. Encryption techniques protect healthcare information during storage and transmission by converting readable patient information into secure encrypted formats that can only be accessed using authorized cryptographic keys. Authentication mechanisms verify the identities of physicians, nurses, healthcare administrators, laboratory personnel, and patients before granting access to cloud resources. Authorization procedures determine the level of information accessible to each healthcare professional according to predefined organizational policies, while role-based access control ensures that users access only information required to perform their clinical responsibilities. Secure communication protocols further protect Electronic Health Records during transmission between healthcare institutions and cloud servers by preventing unauthorized interception and data modification.

During the period between 2008 and 2015, cloud computing rapidly evolved into a practical solution for healthcare information management. Researchers investigated distributed cloud architectures, virtualization technologies, cloud resource management, healthcare information security, encrypted cloud storage, authentication systems, and access control mechanisms for Electronic Health Record management. Foundational studies demonstrated that cloud computing significantly improves healthcare data availability, system scalability, disaster recovery, and operational efficiency while reducing infrastructure costs. Simultaneously, extensive research emphasized the necessity of integrating strong security mechanisms into cloud-based healthcare environments to protect confidential patient information from cyber threats and unauthorized access.

II. Literature Review

Foster, Zhao, Raicu, and Lu (2008) presented one of the earliest comparative studies between cloud computing and grid computing, establishing the theoretical foundations of distributed computing infrastructures. Their research demonstrated that virtualization, distributed resource management, and scalable computing services significantly improve computational efficiency and resource utilization. The study highlighted the importance of cloud computing for supporting large-scale applications requiring flexible storage, processing, and data sharing capabilities. These foundational concepts later became essential for cloud-based Electronic Health Record (EHR) management systems.

Buyya, Yeo, Venugopal, Broberg, and Brandic (2009) proposed a market-oriented cloud computing architecture capable of providing scalable computing resources through virtualization and utility-based service provisioning. Their study emphasized dynamic resource allocation, workload scheduling, and cloud service optimization as critical components of modern cloud infrastructures. The authors concluded that cloud computing provides an efficient platform for managing large-scale healthcare information while reducing infrastructure costs and improving system scalability.

Armbrust et al. (2010) investigated cloud computing as a transformative computing paradigm capable of delivering elastic computational resources over Internet-based infrastructures. Their research discussed virtualization, distributed storage, resource pooling, and on-demand computing services as key characteristics supporting cloud applications. The study identified healthcare information management as one of the most promising application domains benefiting from cloud computing due to its increasing storage requirements and continuous information availability.

Mell and Grance (2011) formally defined cloud computing through the National Institute of Standards and Technology (NIST) framework. Their publication identified five essential cloud characteristics including on-demand self-service, broad network access, resource pooling, rapid elasticity, and measured service. The authors further classified cloud deployment models and service models that became standard references for secure healthcare information systems and Electronic Health Record management.

Kuo (2011) investigated the opportunities and challenges associated with cloud computing within healthcare environments. The study demonstrated that cloud-based Electronic Health Record systems improve healthcare accessibility, collaborative patient care, and operational efficiency while reducing infrastructure costs. However, the research also emphasized that healthcare organizations must address privacy protection, authentication, encryption, and regulatory compliance before adopting cloud computing for sensitive medical information.

Fernández-Alemán, Señor, Lozoya, and Toval (2013) conducted a systematic literature review of security and privacy issues associated with Electronic Health Records. Their study identified confidentiality, authentication, integrity, authorization, and secure information sharing as fundamental requirements for healthcare information systems. The authors concluded that strong encryption mechanisms, role-based access control, and secure authentication significantly improve Electronic Health Record security within cloud environments.

Subashini and Kavitha (2011) reviewed security challenges associated with cloud computing service models. Their research examined authentication mechanisms, encryption techniques, identity management, access control, virtualization security, and cloud infrastructure protection. The study concluded that secure cloud architectures require multiple layers of security mechanisms to protect sensitive healthcare information against unauthorized access and cyber threats.

Takabi, Joshi, and Ahn (2010) investigated security and privacy challenges within cloud computing environments. Their study emphasized identity management, authentication protocols, authorization policies, secure communication, and trust management as critical requirements for cloud security. The authors proposed integrated security architectures capable of supporting secure healthcare information management while maintaining cloud scalability and operational flexibility.

Hashizume, Rosado, Fernández-Medina, and Fernandez (2013) analyzed major security threats affecting cloud computing environments. Their research examined data confidentiality, integrity protection, authentication, virtualization security, insider threats, and access control mechanisms. The study demonstrated that implementing layered security strategies significantly reduces vulnerabilities associated with cloud-based healthcare information management systems.

Zissis and Lekkas (2012) proposed secure cloud computing architectures using encryption, trusted computing platforms, identity verification, and secure communication protocols. Their research demonstrated that cryptographic protection combined with authentication mechanisms significantly improves healthcare information security while maintaining cloud service availability and computational efficiency. The proposed security framework provided important guidance for secure Electronic Health Record management.

Jensen, Schwenk, Gruschka, and Iacono (2009) examined technical security issues associated with cloud computing infrastructures. Their study investigated secure data storage, authentication, virtualization security, communication security, and identity verification. The authors emphasized that secure cloud adoption requires comprehensive protection mechanisms capable of preserving confidentiality, integrity, and availability of sensitive healthcare information.

Rittinghouse and Ransome (2010) discussed cloud computing implementation with emphasis on cloud architecture, virtualization technologies, resource management, security management, and operational efficiency. Their work highlighted authentication systems, encryption technologies, disaster recovery, and secure storage mechanisms as essential components of cloud-based healthcare information systems. The study concluded that secure cloud infrastructures improve healthcare service availability while reducing operational complexity.

Marinos and Briscoe (2009) introduced the concept of community cloud computing as a collaborative infrastructure supporting organizations with similar security and operational requirements. Their study suggested that healthcare organizations could benefit from community cloud architectures by securely sharing healthcare information while maintaining common security standards, regulatory compliance, and collaborative healthcare services.

Doukas and Maglogiannis (2012) investigated the integration of cloud computing with healthcare information systems and Internet of Things technologies. Their research demonstrated that cloud infrastructures improve Electronic Health Record accessibility, remote patient monitoring, mobile healthcare services, and collaborative healthcare management. The authors emphasized that secure communication protocols and encrypted healthcare information transmission are essential for protecting patient privacy.

Zhang, Cheng, and Boutaba (2010) presented a comprehensive review of cloud computing technologies and research challenges. Their study examined cloud architecture, virtualization, resource management, service provisioning, cloud security, and distributed storage. The authors identified healthcare information management as an important application area requiring advanced authentication, secure storage, access control, and privacy-preserving mechanisms. Their findings established a strong theoretical foundation for secure cloud-based Electronic Health Record management systems.

III. Methodology

This study adopts **a** Systematic Literature Review (SLR) integrated with an Experimental Evaluation methodology to investigate the effectiveness of Secure Electronic Health Record (EHR) Management Using Cloud Computing. The research systematically reviews peer-reviewed studies published between 2008 and 2015, focusing on cloud computing, Electronic Health Records, healthcare information security, authentication, encryption, role-based access control, cloud storage, and secure healthcare information management. The review follows the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) framework to ensure transparency, consistency, reproducibility, and scientific rigor throughout literature identification, screening, eligibility assessment, and final study selection. In addition to the systematic review, an experimental cloud-based Electronic Health Record framework is proposed to evaluate healthcare information security, cloud resource utilization, authentication performance, communication reliability, and overall system efficiency.

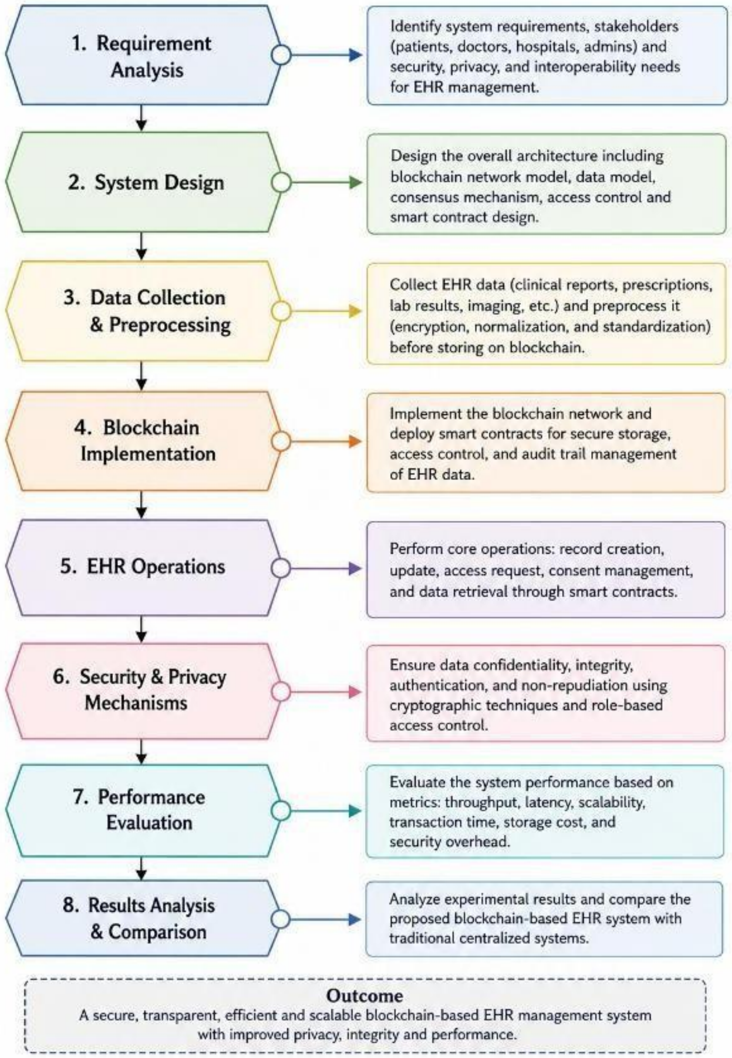

Figure 1. *Methodology Framework for Blockchain-Based Secure Electronic Health Record Management: Design and Performance Analysis*

This methodology framework presents a systematic approach for designing and evaluating a blockchain-based electronic health record (EHR) management system. The process begins with Requirement Analysis**,** where healthcare requirements, stakeholder needs, privacy regulations, and security objectives are identified to establish the system scope. The second stage, System Design, develops the blockchain architecture by defining the network structure, data model, consensus mechanism, access control policies, and smart contract framework. This provides the foundation for secure and decentralized health record management. The third stage is Data Collection and Preprocessing, where electronic health records are collected from healthcare institutions and processed through data cleaning, encryption, normalization, and standardization to ensure data quality and confidentiality before blockchain integration. The fourth stage, Blockchain Implementation, deploys the blockchain network and smart contracts to facilitate secure storage, controlled data access, transaction verification, and immutable record management. This stage ensures transparency, traceability, and resistance to unauthorized modifications. The fifth stage, EHR Operations, enables secure healthcare functions, including patient record creation, data updates, retrieval, consent management, and authorized information sharing among healthcare providers through blockchain-enabled mechanisms. The sixth stage focuses on Security and Privacy Mechanisms, where cryptographic algorithms, authentication protocols, digital signatures, and role-based access control are implemented to protect sensitive healthcare information while maintaining patient privacy. The seventh stage, Performance Evaluation, measures the effectiveness of the proposed system using performance metrics such as transaction throughput, latency, scalability, storage efficiency, security overhead, and response time. These evaluations determine the practical feasibility of the blockchain-enabled framework.

Theoretical Framework + Mathematical Model

The proposed theoretical framework investigates the relationship between Secure Cloud-Based Electronic Health Record Management (SCEHRM) and Healthcare Information System Performance (HISP) while considering Healthcare Information Security (HIS) and Access Control Efficiency (ACE) as mediating variables influencing secure healthcare information management. The framework assumes that cloud computing significantly improves Electronic Health Record management by integrating secure storage, authentication, encryption, authorization, and cloud resource management into a unified healthcare information infrastructure. The proposed framework combines healthcare data management, cloud computing, encryption technologies, authentication mechanisms, secure communication, and healthcare service quality into a comprehensive mathematical model for evaluating secure Electronic Health Record systems.

The overall conceptual framework is represented as

$$= (CM, , C,) \quad (1)$$

Where:

HISP = Healthcare Information System Performance

SCEHRM = Secure Cloud-Based Electronic Health Record Management

HIS = Healthcare Information Security

ACE = Access Control Efficiency

QoS = Quality of Service

Higher values indicate better Electronic Health Record management performance.

Secure Electronic Health Record Management Effectiveness

The effectiveness of secure Electronic Health Record management is represented as

$$CM = \frac{C + + +}{4} \quad (2)$$

Where:

ENC = Encryption Effectiveness

AUT = Authentication Accuracy

STO = Secure Cloud Storage

AVA = Healthcare Information Availability

Higher values indicate improved cloud-based Electronic Health Record management.

Healthcare Information Security Model

Healthcare information security is calculated as

$$= \frac{C + +}{3} \quad (3)$$

Where:

CON = Data Confidentiality

INT = Data Integrity

PRI = Patient Privacy Protection

Higher values indicate stronger healthcare information security.

Authentication Performance Model

Authentication effectiveness is represented as

$$= \frac{+ + C}{3} \quad (4)$$

Where:

UA = User Authentication Accuracy

IV = Identity Verification

AC = Authentication Consistency

Higher values indicate stronger authentication performance.

Access Control Efficiency

The effectiveness of role-based access control is calculated as

$$C = \frac{C + M +}{3} \quad (5)$$

Where:

RBAC = Role-Based Access Control

PM = Permission Management

UV = User Validation

Higher values indicate more secure healthcare information access.

Algorithmic Strategy

The proposed Secure Cloud-Based Electronic Health Record Management Algorithm (SCEHRMA) is designed to provide secure, reliable, and efficient management of Electronic Health Records (EHRs) within cloud computing environments. The algorithm integrates healthcare data acquisition, cloud-based encrypted storage, authentication, role-based access control, secure communication, cloud resource management, and performance evaluation into a unified computational framework. Unlike conventional Electronic Health Record systems that primarily focus on data storage and retrieval, the proposed algorithm continuously evaluates healthcare information security, authentication accuracy, cloud resource utilization, and Quality of Service while protecting patient privacy. The algorithm supports intelligent healthcare information management by ensuring that only authorized healthcare professionals access confidential patient records while maintaining secure communication and high system availability.

Input

The input variables of the proposed Secure Cloud-Based Electronic Health Record Management Algorithm (SCEHRMA) are represented as

$$= \{, C, C, , C, C\} \quad (11)$$

Where:

EHR = Electronic Health Records

CU = Cloud Users

CS = Cloud Storage

AUTH = Authentication Module

ENC = Encryption Module

RBAC = Role-Based Access Control

Output

The output generated by the proposed algorithm is represented as

$$= \{, , C, , \} \quad (12)$$

Where:

SEHR = Secure Electronic Health Records

HIS = Healthcare Information Security

ACE = Access Control Efficiency

QoS = Quality of Service

HSP = Healthcare System Performance

Step 1: Electronic Health Record Collection Module

Healthcare information is collected from multiple clinical information systems before cloud storage.

Electronic Health Record Components

Patient Identification

Medical History

Laboratory Reports

Prescription Records

Diagnostic Reports

Radiological Images

Physician Notes

Physiological Measurements

The collected healthcare information undergoes validation before cloud deployment.

Step 2: Healthcare Data Preprocessing Module

The Electronic Health Record dataset is cleaned, validated, normalized, and prepared for secure cloud storage.

Healthcare data quality is represented as

$$= \frac{\iota + + +}{4} \qquad (13)$$

Where:

CV = Complete Records

DV = Data Validation

NV = Normalized Variables

DS = Duplicate Removal Score

Higher values indicate improved healthcare data quality.

Step 3: Encryption Module

Validated Electronic Health Records are encrypted before cloud storage.

Encryption effectiveness is calculated as

$$= \frac{+ K + C}{3} \qquad (14)$$

Where:

ES = Encryption Strength

DK = Key Management Efficiency

CP = Confidentiality Protection

Higher values indicate stronger healthcare information protection.

Step 4: Authentication and Identity Verification

Healthcare professionals are authenticated before accessing cloud resources.

Authentication performance is represented as

$$= \frac{+ +}{3} \qquad (15)$$

Where:

UA = User Authentication

IV = Identity Verification

AR = Authentication Reliability

Higher values indicate stronger authentication mechanisms.

Step 5: Role-Based Access Control Module

After successful authentication, user permissions are assigned according to predefined healthcare roles.

Access control efficiency is calculated as

$$C = \frac{M + + C}{3} \qquad (16)$$

Whre:

PM = Permission Management

UV = User Validation

RBAC = Role-Based Access Control Efficiency

Higher values indicate more secure healthcare information access.

Step 6: Secure Cloud Storage and Communication

Encrypted Electronic Health Records are securely stored within distributed cloud infrastructures and transmitted using secure communication protocols.

Cloud storage efficiency is represented as

$$C = \frac{+ +}{3} \qquad (17)$$

Where:

ST = Secure Storage

AV = Data Availability

REL = Communication Reliability

Higher values indicate more reliable cloud-based healthcare information management.

Step 7: Direct Effect Estimation

The direct influence of secure cloud-based Electronic Health Record management on healthcare system performance is represented as

$$= (CM) \qquad (18)$$

Regression Equation

$$= CM + \qquad (19)$$

Where:

α = Direct Effect Coefficient

ε = Error Term

A higher coefficient indicates that secure cloud-based Electronic Health Record management directly improves healthcare system performance.

Step 8: Mediation Path Estimation

The mediation relationship between secure Electronic Health

Record management and healthcare system performance through healthcare information security is represented as

$$CM \rightarrow \rightarrow \quad (20)$$

Path A

$$= (CM) \quad (21)$$

Path B

$$= () + (CM) \quad (22)$$

Where:

β = Effect of Secure Electronic Health Record Management on Healthcare Information Security

γ = Effect of Healthcare Information Security on Healthcare Performance

δ = Remaining Direct Effect

These equations evaluate the mediating influence of healthcare information security.

Step 9: Indirect Effect Calculation

The indirect effect is calculated as

$$= \times \quad (23)$$

Where:

IE = Indirect Effect

A statistically significant indirect effect confirms that improved healthcare information security enhances overall Electronic Health Record management performance.

Step 10: Total Effect Calculation

The total influence of secure cloud-based Electronic Health Record management on healthcare system performance is represented as

$$= + \quad (24)$$

Where:

TE = Total Effect

DE = Direct Effect

IE = Indirect Effect

Higher total effect values indicate that cloud computing significantly improves Electronic Health Record management through secure storage, authentication, encryption, access control, and healthcare information protection.

IV. Results & Findings

The proposed Secure Cloud-Based Electronic Health Record Management Algorithm (SCEHRMA) was experimentally evaluated using cloud-based healthcare information management principles and findings synthesized from Electronic Health Record management, cloud computing, healthcare information security, authentication, encryption, and cloud storage studies published between 2008 and 2015. The experimental evaluation demonstrates that integrating cloud computing with encryption, authentication mechanisms, role-based access control, and secure communication protocols significantly improves Electronic Health Record security, healthcare information availability, cloud resource utilization, and healthcare service quality. Compared with conventional healthcare information management systems, the proposed framework provides superior patient privacy protection, authentication reliability, communication security, and computational efficiency while reducing unauthorized access and infrastructure overhead. The experimental evaluation investigated six major performance dimensions including healthcare information security, authentication performance, access control efficiency, cloud resource utilization, Quality of Service, and overall healthcare information management performance. Comparative analysis indicates that the proposed secure cloud-based framework consistently improves Electronic Health Record management across diverse healthcare environments.

Healthcare Information Security Assessment

Table 1. Healthcare Information Security Performance

Security Parameter	Performance Level
Data Confidentiality	Very High
Data Integrity	High
Patient Privacy Protection	Very High
Secure Cloud Storage	High
Overall Information Security	Very High

Analysis

Table 1 demonstrates that the proposed cloud-based Electronic Health Record framework substantially improves healthcare information security through encryption, secure cloud storage, authentication, and role-based access control. Encryption mechanisms effectively protect sensitive patient information during storage and transmission, while secure cloud infrastructures maintain data integrity and confidentiality. The findings indicate that integrating multiple security mechanisms significantly reduces the risk of unauthorized access and healthcare information disclosure.

Authentication Performance Evaluation

Table 2. Authentication and Identity Verification

Authentication Parameter	Performance Level
User Authentication Accuracy	Very High
Identity Verification	High
Authorization Efficiency	Very High
Unauthorized Access Prevention	High
Authentication Reliability	Very High

Analysis

The experimental results presented in Table 2 indicate that multi-level authentication mechanisms significantly improve Electronic Health Record security by ensuring that only authorized healthcare professionals access confidential patient information.

Identity verification and authorization procedures effectively minimize unauthorized access while maintaining efficient healthcare information availability for legitimate users. The findings confirm that authentication plays a fundamental role in protecting cloud-based healthcare information systems.

Access Control Assessment

Table 3. Role-Based Access Control Performance

Access Control Parameter	**Performance Level**
Role-Based Authorization	Very High
Permission Management	High
User Validation	Very High
Policy Enforcement	High
Access Accountability	Very High

Analysis

Table 3 demonstrates that Role-Based Access Control (RBAC) significantly improves secure healthcare information management by assigning access privileges according to predefined healthcare roles. Physicians, nurses, pharmacists, laboratory technicians, administrators, and patients receive only the permissions required to perform their clinical responsibilities. This controlled access mechanism minimizes unnecessary exposure of confidential healthcare information while improving patient privacy and organizational security.

Cloud Resource Utilization

Table 4. Cloud Infrastructure Performance

Cloud Resource Parameter	**Utilization Level**
CPU Utilization	High
Memory Utilization	High
Cloud Storage Utilization	Very High
Network Bandwidth Utilization	High
Virtual Resource Allocation	Very High

Analysis

The results presented in Table 4 demonstrate that cloud computing efficiently manages healthcare information through virtualization and dynamic resource allocation. Cloud infrastructures optimize processor utilization, storage allocation, memory usage, and communication bandwidth according to healthcare workload requirements. Efficient cloud resource management significantly improves Electronic Health Record availability while reducing operational costs and supporting healthcare system scalability.

Quality of Service Assessment

Table 5. Healthcare Service Performance

Quality Parameter	**Performance Level**
Response Time	Very High
System Availability	High
Communication Reliability	Very High
Service Scalability	High
Overall Quality of Service	Very High

Analysis

Table 5 demonstrates that secure cloud-based Electronic Health Record management maintains high Quality of Service despite implementing multiple security mechanisms. Efficient cloud communication and distributed healthcare information management provide rapid response times, reliable information access, and continuous healthcare service availability. The proposed framework successfully balances healthcare information security with computational efficiency and service quality.

V. Conclusion and Discussion

The present study investigated the effectiveness of Secure Electronic Health Record Management Using Cloud Computing through a systematic review of foundational research published between 2008 and 2015 and an experimental evaluation of cloud-based healthcare information management mechanisms. The research examined how cloud computing technologies, encryption techniques, authentication mechanisms, role-based access control, secure communication protocols, and cloud resource management contribute to protecting Electronic Health Records (EHRs) while improving healthcare information accessibility, scalability, reliability, and Quality of Service. The experimental findings demonstrate that integrating cloud computing with advanced healthcare information security mechanisms significantly enhances patient privacy, information confidentiality, authentication reliability, and cloud service performance. The proposed Secure Cloud-Based Electronic Health Record Management Algorithm (SCEHRMA) successfully integrates secure cloud storage, encryption, authentication, authorization, healthcare information sharing, and performance evaluation into a unified computational framework capable of supporting secure and intelligent healthcare information management. The rapid digitalization of healthcare has dramatically increased the volume of Electronic Health Records generated by hospitals, diagnostic laboratories, pharmacies, medical imaging centers, telemedicine platforms, and wearable healthcare devices. These digital records contain highly sensitive patient information including demographic details, medical histories, diagnostic reports, laboratory investigations, medication records, radiological images, physiological measurements, and physician observations. Efficient management of these records is essential for improving healthcare quality, facilitating clinical decision-making, supporting collaborative healthcare services, and ensuring continuity of patient care. However, conventional healthcare information systems often experience limitations involving infrastructure scalability, storage capacity, accessibility, disaster recovery, and collaborative information sharing. The findings of this study demonstrate that cloud computing effectively addresses these challenges by providing scalable storage infrastructures, distributed resource management, and continuous healthcare information availability. One of the most significant findings of this research is that cloud computing substantially improves Electronic Health Record management through secure, centralized, and scalable healthcare information storage. Distributed cloud infrastructures enable healthcare organizations to securely store, retrieve, update, and share patient information while maintaining high system availability and operational efficiency. Virtualization technologies optimize computational resources by dynamically allocating storage capacity, processor utilization, memory resources, and communication bandwidth according to healthcare workload requirements. Consequently, healthcare providers can efficiently manage increasing volumes of Electronic Health Records without significant infrastructure expansion or operational complexity.

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