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ANALYSIS OF BLOCKCHAIN-BASED PATIENT DATA MANAGEMENT AT DR. M.M. DUNDA LIMBOTO HOSPITAL

Ayu Wandira I. Abunawas[1], Adnan Malaha[2], Juliko Suleman[3]
[1,2,3]Universitas Bina Mandiri Gorontalo
Email : wayu0906@gmail.com, adnan.malaha@ubmg.ac.id, doktericko2025@gmail.com

ABSTRACT

Blockchain technology offers potential for improving the security, traceability, and management of patient data in healthcare institutions. However, its practical implementation depends not only on technological capabilities but also on human resource readiness, usability, service processes, data security, and system integration. This study aimed to analyze blockchain-based patient data management at Dr. M.M. Dunda Limboto Regional General Hospital, focusing on staff satisfaction, ease of use, service quality, data security, and system integration. A descriptive qualitative design was employed, with data collected in November 2025 through observation, semi-structured interviews, and documentation. Four informants representing hospital management, human resources, information technology, and medical records were selected based on their involvement in patient data management. Data were analyzed through organization, reduction, categorization, data display, cross-source comparison, and conclusion drawing. The findings indicate that blockchain-based patient data management was perceived to support data traceability, transparency, access control, and the preservation of record histories. The system was considered relatively simple to use, although patient access to information remained dependent on medical personnel. Human resource limitations, particularly IT workload and staff adaptation, were identified as important challenges. Data security was supported by authentication, role-based access, standard operating procedures, and reported encryption mechanisms. However, integration with the broader hospital information system remained incomplete, with some processes still conducted manually. The study concludes that effective blockchain-based patient data management requires not only technological implementation but also continuous staff development, adequate infrastructure, stronger interoperability, and improved integration of information systems.

Keywords: blockchain; patient data management; data security; system integration; hospital information system

INTRODUCTION

The rapid development of digital technology has transformed the management of health information in hospitals. Patient data, including medical records, diagnostic results, treatment histories, and administrative information, are increasingly managed through digital information systems. The availability of digital patient data can support healthcare providers in delivering faster and more integrated services. However, the increasing volume and sensitivity of health information also create significant challenges related to data security, privacy, integrity, accessibility, and interoperability among healthcare providers. Therefore, hospitals require data management systems that are not only capable of storing patient information but also able to ensure that

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such information is protected, reliable, and appropriately accessible.

Blockchain technology has emerged as one of the technologies with potential applications in healthcare data management. Its decentralized and tamper-resistant characteristics can provide an alternative mechanism for maintaining the integrity and security of patient records. Blockchain can record transactions in a manner that makes unauthorized alteration more difficult and can provide an auditable history of data-related activities. In addition, cryptographic mechanisms, including hashing and digital signatures, can be incorporated to strengthen the protection of sensitive health information [1][2][3]. These characteristics make blockchain relevant to healthcare environments in which confidentiality and data integrity are critical requirements.

In addition to security, blockchain has the potential to improve the sharing of patient information among healthcare providers. Healthcare organizations frequently operate information systems that are not fully interconnected, resulting in data silos and difficulties in exchanging information across institutions. Blockchain-based health information systems can facilitate secure and transparent data sharing while supporting interoperability among hospitals, laboratories, and other healthcare providers [4][5]. Smart contracts can also be used to manage access permissions and automate certain transactions, potentially providing patients and authorized healthcare providers with greater control over the use and sharing of health information [6][7]. Consequently, blockchain is increasingly discussed as a potential technological foundation for improving patient data management and healthcare information exchange.

The application of blockchain in hospital environments, however, is not without challenges. Integrating blockchain with existing hospital information systems and legacy infrastructure can be complex and resource-intensive [8]. Healthcare data also have particular characteristics that create scalability and performance challenges because patient records may involve large volumes of clinical information that need to be accessed and processed efficiently [9]. Furthermore, the management of patient consent, privacy, access rights, and regulatory compliance requires careful consideration when decentralized technologies are introduced into healthcare environments. Thus, the adoption of blockchain cannot be assessed solely from its technological advantages but must also be examined from organizational, operational, security, and system-integration perspectives.

Previous studies have predominantly discussed blockchain-based healthcare systems in terms of proposed architectures, security mechanisms, data-sharing models, and technological frameworks. Although these studies demonstrate the potential of blockchain to strengthen patient data management, practical implementation within hospital environments remains an important issue. Westphal and Seitz [8], emphasized that concrete and large-scale implementations of blockchain for patient data management remain limited, with many initiatives still positioned at the conceptual or pilot stage. This indicates a need for empirical studies that examine how blockchain-based patient

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data management is experienced and implemented within actual hospital environments, particularly in relation to usability, service quality, data security, staff experience, and system integration.

In the Indonesian healthcare context, this issue is particularly relevant as hospitals increasingly rely on hospital information systems to support administrative and clinical processes. The effectiveness of digital patient data management depends not only on the availability of information technology but also on the capacity of healthcare personnel, supporting infrastructure, data security mechanisms, and the integration of different information systems. Understanding these aspects is important for determining whether blockchain-based approaches can provide practical value within hospital operations.

Dr. M.M. Dunda Limboto Hospital provides a relevant setting for examining blockchain-based patient data management because patient information management involves multiple stakeholders and requires coordination between healthcare personnel, information technology staff, medical record personnel, and hospital management. However, the implementation of a technology such as blockchain should be examined comprehensively rather than evaluated solely on the basis of its technological concept. Organizational experience, ease of use, service quality, data security, and system integration are important dimensions for understanding the actual condition of patient data management within the hospital.

Based on this background, this study aims to analyze blockchain-based patient data management at Dr. M.M. Dunda Limboto Hospital. The analysis focuses on staff experience, ease of system use, service quality, data security, and system integration. By examining these dimensions, the study is expected to provide an empirical description of the implementation and challenges of blockchain-based patient data management in a hospital setting and contribute practical insights for the development of secure, integrated, and sustainable health information management systems.

RESEARCH METHODS

Research Design

This study employed a descriptive qualitative research design to analyze blockchain-based patient data management at Dr. M.M. Dunda Limboto Regional General Hospital. A qualitative design was selected because the study sought to obtain an in-depth understanding of the experiences, perceptions, practices, and challenges associated with the use of the system from the perspectives of personnel directly involved in hospital management and patient data services [10]. The study did not involve experimental intervention or modification of the existing information system; rather, it examined the existing conditions through direct observation, interviews, and documentation.

The analysis focused on five aspects identified in accordance with the research framework: staff satisfaction, ease of use, service quality, data security, and system integration. These aspects were explored through the experiences and explanations of hospital management, human resources personnel, information technology personnel, and medical records personnel.

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The descriptive qualitative design enabled the researchers to synthesize information from these different perspectives and provide a contextual description of the implementation of blockchain-based patient data management in the hospital.

Research Setting and Participants

The study was conducted at Dr. M.M. Dunda Limboto Regional General Hospital, Gorontalo, Indonesia. The hospital was selected as the research setting because patient data management involves multiple organizational units and requires coordination between hospital management, human resources, information technology personnel, and medical records personnel. Data collection was conducted in November 2025 through direct observation, interviews, and documentation of activities and information relevant to patient data management.

Four informants participated in the study. They consisted of a hospital director/deputy director, the head of human resources and personnel affairs, the head of information technology, and the person in charge of medical records. These participants were selected because their positions provided direct knowledge and involvement in hospital management, human resource readiness, information system management, and patient medical record administration. To protect confidentiality, the informants were identified using initials in the presentation of the findings.

Table 1. Characteristics of Research Informants

Informant	Initials	Gender	Position	Years of Service
Informant 1	AKN	Female	Director/Deputy Director, Dr. M.M. Dunda Limboto Regional Hospital	2 years
Informant 2	NMH	Female	Head of Human Resources and Personnel Affairs	5 years
Informant 3	ARH	Male	Head of Information Technology	9 years 8 months
Informant 4	RP	Female	Person in Charge of Medical Records	13 years

Data Collection

Data were collected using three complementary techniques: observation, semi-structured interviews, and documentation. The use of multiple data collection techniques was intended to obtain information from different sources and perspectives concerning the management of patient data and the operation of the hospital information system. The data collection process was guided by the research focus and conceptual framework, particularly the five analytical aspects examined in the study.

1. **Observation**

   Observation was conducted directly at Dr. M.M. Dunda Limboto Regional General Hospital to obtain contextual information regarding patient data management and the hospital information system. The researchers observed relevant activities and conditions associated with system use, patient data management, information technology support, and

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interactions between personnel and the system. Initial observations were also used to obtain an overview of the research setting and to identify issues that required further clarification during the interviews.

The observations were documented using an observation sheet prepared in accordance with the research focus. Where clarification was required, the researchers communicated informally with relevant personnel, particularly information technology and medical records staff. Observation findings were subsequently considered alongside interview and documentation data during the analysis.

2. Semi-Structured Interviews

Semi-structured, in-depth interviews were conducted with the four selected informants. An interview guide consisting of 32 questions was developed based on the research topic, research objectives, and five analytical aspects: staff satisfaction, ease of use, service quality, data security, and system integration. The semi-structured format allowed the researchers to maintain consistency across interviews while providing informants with sufficient opportunity to explain their experiences, practices, and perceptions in detail.

The interviews focused on the practical conditions surrounding patient data management, including staff adaptation and training, system usability, service processes, data protection and access control, system integration, and technological and organizational challenges. Interviews were conducted directly with the informants in November 2025, and relevant responses were recorded and organized according to the corresponding research themes. Informant quotations presented in the Results section were used to illustrate important findings derived from the interviews.

3. Documentation

Documentation was used as a complementary data source to support information obtained through observation and interviews. The researchers examined relevant records and materials associated with patient data management, hospital information systems, system procedures, and other documents available within the research setting. Documentation was also used to provide contextual information concerning access procedures, system management, and organizational practices related to patient data.

The documentation data were reviewed according to their relevance to the research objectives and compared with information obtained from interviews and observations. This process helped the researchers develop a more comprehensive description of the conditions surrounding blockchain-based patient data management.

Data Analysis

Data analysis was conducted through an iterative process consisting of data organization, data reduction, data categorization, data display, and conclusion drawing. First, information obtained from interviews, observations, and documentation was organized according to the informant, data source, and research focus. The researchers then reviewed the

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collected information to identify statements and observations relevant to the study objectives. This initial organization facilitated systematic comparison of information obtained from different participants and data sources.

The researchers subsequently reduced the data by selecting information directly related to the five analytical aspects of the study: staff satisfaction, ease of use, service quality, data security, and system integration. Relevant statements were grouped according to similarities in meaning and recurring issues. The categorized information was then presented descriptively through a structured narrative supported by selected informant quotations. Patterns, similarities, differences, and relationships among the findings were examined to develop an overall interpretation of patient data management. Finally, conclusions were drawn after reviewing the consistency between the emerging findings, the research objectives, and the information obtained from the different data sources.

Data Trustworthiness

The trustworthiness of the qualitative findings was supported through the use of multiple data collection techniques and perspectives. Information obtained from interviews was considered together with observations and available documentation rather than being interpreted independently. In addition, perspectives from four informants representing different functional areas of the hospital were compared to identify consistency and differences in their accounts concerning patient data management.

The researchers also reviewed the consistency of the emerging findings with the original research focus before drawing conclusions. Particular attention was given to information concerning staff readiness, system usability, service quality, data security, and system integration. This process was intended to ensure that the interpretation reflected the information obtained in the field and remained aligned with the scope of the study.

Ethical Considerations

The study involved interviews with hospital personnel concerning organizational practices and patient data management. Accordingly, the researchers maintained the confidentiality of informants by presenting their responses using initials rather than full names. The study did not present identifiable patient information in the research findings. Information obtained during the research was used solely for academic and research purposes.

Participation in the interviews was conducted after the informants were informed about the purpose and scope of the study. The researchers also limited the presentation of sensitive information to material relevant to the research objectives and avoided disclosing confidential patient information or personally identifiable data.

RESEARCH RESULTS

Staff Satisfaction and Human Resource Readiness

The findings indicate that the implementation of blockchain-based patient data management has increased the responsibilities of hospital staff, particularly because data management is distributed across organizational units. This condition requires staff to have adequate knowledge, discipline, and readiness to

perform their respective responsibilities. As stated by NMH:

> *"Yes, decentralization can affect the duties and responsibilities of HR, each unit has greater responsibilities including administration, service, and operational decision-making."* (NMH, 19 November 2025)

Staff training was identified as one of the mechanisms used to support the implementation of the system. NMH explained:

> *"Regular training is usually provided to ensure staff understand how blockchain works… so they can use the system correctly."* (NMH, 19 November 2025)

From the technical perspective, the system was reportedly designed to be relatively simple for users. ARH stated:

> *"Patient data management… is designed to be simple… regular training may also be provided so that staff understand how to use it without having to understand the technical aspects."* (ARH, 11 November 2025)

However, the findings also reveal limitations in human resource readiness. AKN simply identified the presence of:

> *"Untrained human resources."* (AKN, 19 November 2025)

NMH further emphasized that adaptation to the new technology remained a challenge:

> *"The biggest challenge for HR is adapting staff skills and understanding to new technologies, requiring high discipline in adherence to security procedures."* (NMH, 19 November 2025)

The shortage of personnel was particularly evident in the IT unit. ARH stated:

> *"HR is very lacking, the IT workload is high, the work includes networks, servers, applications, hardware."* (ARH, 11 November 2025)

These findings indicate that staff readiness remains an important organizational factor in the implementation of blockchain-based patient data management. Although training and a relatively simple system interface may facilitate adoption, limited human resources, staff adaptation, and the workload of the IT unit remain significant operational challenges.

Ease of Use

The findings indicate that the system was perceived as relatively easy to use by hospital staff. The system was reportedly designed with a simple interface that does not require users to possess extensive technical knowledge of blockchain. ARH explained:

> *"The system is designed to be simple with an easy-to-use interface that does not require understanding the technical aspects of blockchain."* (ARH, 11 November 2025)

Routine evaluation was also reported as part of the system management process. AKN stated:

> *"Daily evaluation."* (AKN, 19 November 2025)

In addition to formal system evaluation, internal communication was

supported through digital communication channels. AKN reported:

> *"There is a WhatsApp group."* (AKN, 19 November 2025)

The findings further indicate that patients did not necessarily have direct access to their information through the system. In such situations, hospital personnel served as an intermediary for providing information. RP explained:

> *"Patients who cannot directly access information can be provided through medical personnel."* (RP, 19 November 2025)

Thus, ease of use was observed primarily from the perspective of hospital staff and organizational workflows. Although the system interface was considered simple, accessibility for patients remained dependent on the involvement of medical personnel.

Service Quality

The findings indicate that blockchain-based data management was associated with mechanisms for maintaining transparency and traceability of patient information. NMH stated:

> *"Blockchain increases transparency of every activity permanent, sequential, and traceable medical personnel can see the complete history of actions."* (NMH, 19 November 2025)

The ability to retain data history was also reflected in the reported procedure for correcting recording errors. NMH explained:

> *"If there is an error in recording… an addendum is made as new data."* (NMH, 19 November 2025)

Similarly, ARH stated:

> *"IT creates a new block as a correction… history remains recorded."* (ARH, 11 November 2025)

These statements indicate that corrections were reportedly performed by adding new information rather than deleting the previous record, thereby allowing the history of changes to remain available.

However, the findings also reveal limitations in the broader hospital information system. RP stated:

> *"Because the hospital's SIM is not yet optimal, the medical records section is still pulling data manually so they are not aware of the delay in data access."* (RP, 19 November 2025)

Therefore, although respondents described mechanisms supporting transparency and traceability, the overall service process was still affected by incomplete integration of the hospital information system and the continued use of manual procedures in certain medical record activities.

Data Security

Data security emerged as an important component of patient data management. The findings indicate that user authentication and differentiated access rights were implemented within the hospital information system. AKN stated:

> *"Dunda Regional General Hospital has used a Hospital SIM where each user has a username and password."* (AKN, 19 November 2025)

Access was reportedly differentiated according to staff

responsibilities and confidentiality requirements. NMH explained:

> *"HR ensures that only authorized staff can access data… access levels are divided according to position and confidentiality training."* (NMH, 19 November 2025)

This access-control mechanism was supported by specific standard operating procedures. RP stated:

> *"There is an SOP for authorized users, doctors, nurses, registration has its own login."* (RP, 19 November 2025)

The findings also indicate that access to certain sensitive medical information was restricted. RP explained:

> *"Only a few people can access the diagnosis code using ICD coding."* (RP, 19 November 2025)

and further stated:

> *"Each has access rights and cannot access other operators' data."* (RP, 19 November 2025)

From the IT perspective, encryption and private-key mechanisms were reported as part of the security architecture. ARH stated:

> *"Blockchain stores data in encryption that cannot be changed without the consent of the entire system."* (ARH, 11 November 2025)

ARH further explained:

> *"High-level encryption only parties with the private key can access."* (ARH, 11 November 2025)

Institutional measures were also reported to complement the technical mechanisms. AKN stated:

> *"Every officer is given access and makes an integrity pact."* (AKN, 19 November 2025)

Taken together, the interview findings show that data security was supported by several layers of control, including authentication, role-based access, standard operating procedures, restricted access to sensitive information, and reported encryption mechanisms. However, these findings represent the practices and perceptions reported by the informants. The study did not independently verify the cryptographic implementation, conduct penetration testing, or perform a formal information-security audit. Therefore, the reported mechanisms should not be interpreted as independent evidence that the technical security of the blockchain system has been fully validated.

System Integration

The findings indicate that the information technology infrastructure included mechanisms intended to support the stability and monitoring of the system. ARH reported:

> *"IT uses PBFT consensus mechanism real-time monitoring of high capacity servers maintains stability."* (ARH, 11 November 2025)

This statement suggests that the hospital's IT personnel associated the system with a Practical Byzantine Fault Tolerance (PBFT) consensus mechanism, real-time monitoring, and high-capacity server infrastructure.

However, the findings also reveal that integration within the broader hospital

information system remained incomplete. RP stated:

> *"The hospital's SIM is not yet fully integrated, so audits cannot be carried out."* (RP, 19 November 2025)

The need for further infrastructure and human resource development was also emphasized by ARH:

> *"Referring to BPJS and Ministry of Health regulations, IT infrastructure updates and human resource capacity improvements are needed."* (ARH, 11 November 2025)

In addition, RP identified several practical barriers:

> *"The biggest challenges: budget, network facilities, human resources, and concern in inputting data."* (RP, 19 November 2025)

These findings indicate a discrepancy between the reported technical mechanisms supporting the blockchain system and the broader level of hospital information-system integration. Although PBFT, real-time monitoring, and server infrastructure were reported as components supporting system operation, the hospital information system was not yet fully integrated. Budget constraints, network infrastructure, human resource limitations, and inconsistent data-input practices remained important barriers to achieving comprehensive system integration.

Overall, the results demonstrate that the implementation of blockchain-based patient data management involves both technological and organizational dimensions. The main findings concern staff readiness, ease of system use, data traceability, security controls, and system integration. At the same time, several limitations remain, particularly in human resource capacity, incomplete information-system integration, and infrastructure readiness.

DISCUSSION

The findings of this study indicate that blockchain-based patient data management at Dr. M.M. Dunda Limboto Hospital represents not only a technological transformation but also an organizational change that affects human resources, service processes, data security, and information-system integration. The five dimensions examined in this study demonstrate that the effectiveness of blockchain-based patient data management depends on the interaction between technological capabilities and organizational readiness. Although blockchain provides potential advantages in data security, traceability, and information exchange, these benefits cannot be fully realized without adequate human resources, infrastructure, system integration, and organizational support. This finding is consistent with recent literature emphasizing that blockchain-enabled healthcare systems should be viewed within the broader context of healthcare organizational and technological transformation [11][12].

The findings concerning staff satisfaction and human resource readiness demonstrate that personnel capacity is a critical factor in the implementation of blockchain-based patient data management. Respondents reported that decentralization increases the responsibilities of different organizational units and that regular training is needed to

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ensure that personnel understand how to use the system. At the same time, the presence of untrained personnel, staff adaptation difficulties, and limited IT personnel indicate that technological adoption has created additional organizational demands. These findings suggest that blockchain implementation cannot be separated from human-resource development because the ability of employees to understand procedures, maintain data discipline, and comply with security requirements directly influences the sustainability of the system.

The condition of limited IT personnel is particularly significant because the IT unit is responsible for multiple technological components, including networks, servers, applications, and hardware. This situation indicates a potential organizational bottleneck in maintaining a technology-intensive patient data management environment. Zhang et al. [11], highlight the opportunities offered by blockchain-supported smart healthcare while also emphasizing challenges associated with the complexity of implementing emerging technologies in healthcare environments. In the present study, such complexity is reflected not only in the technology itself but also in the workload and competency requirements imposed on hospital personnel. Therefore, staff training should not be regarded as a one-time activity but as a continuous organizational strategy involving technical competency, workflow adaptation, information-security awareness, and role-specific responsibilities.

The finding that the system was perceived as relatively simple to use indicates that usability can support the acceptance of blockchain-based technology among hospital personnel. Respondents stated that users were not required to understand the technical aspects of blockchain because the system was designed with a relatively simple interface. This is important because healthcare workers generally need to concentrate on clinical, administrative, and medical-record activities rather than the technical operation of distributed ledger technology. The finding is broadly consistent with Zhang et al. [11], who identify the potential of blockchain-supported healthcare technologies to improve efficiency and reduce administrative burdens. However, the present findings also show that ease of use should not be interpreted solely in terms of interface simplicity because patients who cannot directly access information remain dependent on medical personnel.

The dependence of patients on medical personnel for accessing information indicates that usability and accessibility represent different dimensions of digital health-system effectiveness. A system may be relatively easy for internal users while still providing limited direct accessibility to patients. This finding is relevant to the user-centered perspective emphasized by Guse et al. [13], who demonstrate the importance of considering user perceptions and experiences in blockchain-based health information exchange. Consequently, the evaluation of blockchain-based patient data management should involve not only hospital employees but also patients and other authorized healthcare stakeholders. Periodic evaluation of user satisfaction, accessibility, workflow efficiency, and potential barriers to information access

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would provide a more comprehensive assessment of system usability.

The findings related to service quality indicate that blockchain-based patient data management was perceived to support transparency and traceability. Respondents explained that activities could be recorded permanently and sequentially and that corrections to medical records could be made through additional entries while maintaining the previous history. From an information-management perspective, the preservation of an activity history is important because it can strengthen accountability and facilitate the monitoring of changes to patient information. This finding is consistent with the literature describing blockchain as a technology capable of creating transparent and traceable records in healthcare environments [11][14]. The ability to maintain a history of transactions may therefore provide organizational value for auditing and accountability.

Nevertheless, the findings demonstrate that blockchain-based traceability does not automatically guarantee improved overall service quality. The hospital's broader information system was reported to be not yet optimal, and medical-record personnel continued to perform certain activities manually. This situation indicates that service quality depends on the entire information-management ecosystem rather than on blockchain functionality alone. Manual data retrieval, fragmented systems, and delays in information access can continue to affect healthcare services even when a blockchain mechanism is available. Therefore, blockchain should be understood as one component of an integrated digital health infrastructure rather than as an independent solution to all service-quality problems.

Data security emerged as one of the most important dimensions of patient data management in this study. The respondents described several security mechanisms, including usernames and passwords, differentiated access rights, standard operating procedures, restricted access to sensitive information, encryption, and private-key mechanisms. These practices demonstrate that patient data protection involves both technical and organizational controls. The findings are consistent with recent literature emphasizing the potential of blockchain to strengthen healthcare data privacy, integrity, and security through decentralized architectures and cryptographic mechanisms [15][14]. In this context, blockchain can provide an additional layer of protection for sensitive health information when appropriately integrated with existing security controls.

However, the reported security mechanisms should be interpreted carefully because the study did not independently verify the technical implementation of the blockchain architecture. No penetration testing, cryptographic verification, vulnerability assessment, or formal information-security audit was conducted. Therefore, the findings demonstrate the security practices and perceptions reported by the informants rather than providing independent evidence that the blockchain system is technically secure against all forms of attack. This distinction is important because blockchain does not eliminate cybersecurity risks associated with compromised credentials, inappropriate access privileges, vulnerable

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applications, or weaknesses in system interfaces. Consequently, blockchain-based security should be complemented by strong authentication, role-based access control, encryption, audit mechanisms, security policies, employee training, and periodic security assessments.

The findings concerning system integration represent one of the most important challenges identified in the study. Although the IT informant reported the use of PBFT consensus, real-time monitoring, and high-capacity servers, the medical-record unit reported that the hospital information system was not yet fully integrated and that certain processes still required manual data retrieval. This condition demonstrates a gap between the reported technological capabilities of the system and the operational integration of the broader hospital information environment. The finding is consistent with previous literature emphasizing interoperability as one of the important potential benefits of blockchain in healthcare [14][13]. However, interoperability cannot be achieved merely by introducing blockchain; it requires compatible systems, standardized data structures, reliable networks, appropriate interfaces, and institutional agreements concerning information exchange.

The reported barriers of budget limitations, network infrastructure, human-resource shortages, and concerns regarding data input further demonstrate that blockchain implementation is influenced by organizational and infrastructural conditions. Siddiqui et al. [12], emphasize the role of technology in improving hospital management efficiency and accessibility, but the present findings show that technological transformation requires adequate supporting resources. In a hospital environment, insufficient infrastructure or limited personnel may reduce the practical benefits of an otherwise capable information system. Therefore, hospital management should conduct a comprehensive readiness assessment before expanding blockchain-based services, including an evaluation of infrastructure, personnel competency, financial capacity, data governance, and interoperability requirements.

The statement concerning the use of PBFT also requires cautious interpretation. PBFT is a technical characteristic that ideally should be demonstrated through system architecture, node configuration, consensus documentation, or transaction-level evidence rather than solely through interviews. Because this study did not conduct a technical audit, the reported use of PBFT should be regarded as the IT personnel's description of the system rather than independently verified evidence. This limitation is important for maintaining methodological consistency and avoiding excessive claims about the technical performance of the blockchain system. Future studies should combine qualitative interviews with technical documentation, system architecture analysis, transaction logs, interoperability testing, and cybersecurity assessments to establish stronger evidence regarding the actual implementation of blockchain mechanisms.

Overall, the findings demonstrate that blockchain-based patient data management at Dr. M.M. Dunda Limboto Hospital is a socio-technical process in which technology and organizational factors are closely interconnected. The

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potential benefits identified in the literature—particularly security, transparency, traceability, and interoperability—are also reflected in the perceptions of hospital personnel. However, the realization of these benefits remains constrained by human-resource limitations, incomplete system integration, infrastructure requirements, manual processes, and financial considerations. This finding extends previous blockchain healthcare literature by showing that the practical effectiveness of blockchain should not be assessed exclusively through its technological characteristics but also through the organizational environment in which the technology operates.

The contribution of this study lies in providing an empirical qualitative perspective on blockchain-based patient data management within a specific hospital context, particularly by highlighting the relationship between technological potential and organizational readiness. Previous studies have frequently focused on blockchain architectures, security mechanisms, privacy protection, and healthcare information exchange [14][15][11], while direct evidence concerning staff readiness, IT workload, usability, and organizational barriers remains comparatively limited. The present findings suggest that successful implementation requires a balanced approach in which technological development is accompanied by continuous human-resource development, stronger governance, improved infrastructure, and progressive integration with existing hospital information systems. The study therefore provides practical evidence that blockchain adoption should be treated as a long-term organizational transformation rather than merely as the introduction of a new information technology.

CONCLUSION

Blockchain-based patient data management at Dr. M.M. Dunda Limboto Regional General Hospital demonstrates potential to support the traceability, transparency, security, and management of patient information, while the system was generally perceived as relatively easy to use by hospital personnel. Nevertheless, the implementation remains influenced by organizational and infrastructural conditions, particularly limited human resources in the information technology unit, the need for continuous staff adaptation and training, dependence on medical personnel for certain patient information access, incomplete integration of the hospital information system, and the continued use of manual processes. Data security has been supported through authentication, differentiated access rights, standard operating procedures, and reported encryption mechanisms, although these technical security features were not independently verified through technical audits or cybersecurity testing. Therefore, the hospital should strengthen human resource capacity through continuous and role-specific training, improve network and IT infrastructure, develop clearer data governance and access-control procedures, and progressively integrate blockchain-based patient data management with the existing hospital information system. Future implementation should also be supported by technical validation, interoperability testing, cybersecurity assessment, and periodic evaluation

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involving hospital staff and patients to ensure that the system provides sustainable improvements in efficiency, accessibility, data security, and quality of healthcare information management.

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