OPEN ACCESS
Journal Neosantara Hybrid Learning
Vol. 4 No. 2. April 2026, pp. 101-112
DOI. 10.70177/jnhl.v4i2.3775
Research Article

DECENTRALIZED LEARNING MANAGEMENT SYSTEMS: BLOCKCHAIN APPLICATIONS IN HYBRID EDUCATION GOVERNANCE

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Article Info
Received: October 8, 2025
Revised: January 18, 2026
Accepted: March 20, 2026
OnlineVersion: April 28, 2026

Abstract
The integration of blockchain technology into hybrid education has the potential to revolutionize the governance of Learning Management Systems (LMS). Traditional LMS often suffer from centralization, which leads to issues such as data security vulnerabilities, inefficiencies in administrative processes, and lack of transparency. Blockchain's decentralized and immutable nature offers a promising solution to these challenges. This study explores the application of blockchain technology in decentralized LMS to enhance governance, transparency, and security in hybrid education environments. The primary aim of the research is to assess how blockchain can be used to improve administrative processes such as grading, credential verification, and accreditation in hybrid learning systems. A qualitative case study approach was used, involving interviews with administrators, educators, and technology experts, as well as document analysis from institutions implementing blockchain-based LMS. The findings reveal that blockchain integration significantly improves data security, reduces administrative delays, and fosters greater trust among stakeholders. Institutions with blockchain-based LMS reported faster processing of student records and a more transparent grading system. The study concludes that blockchain offers a transformative approach to hybrid education governance by creating more secure, transparent, and efficient systems.

Keywords: Blockchain, Decentralized Systems, Governance, Hybrid Education, Learning Management Systems

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Journal Homepage https://research.adra.ac.id/index.php/jnhl ISSN: (P: 2987-2316) - (E: 2986-979X)
How to cite: Mashuri, Mashuri., Suhardiman, Suhardiman., Agus, B. S., & Amelia, L. (2026). Decentralized Learning Management Systems: Blockchain Applications in Hybrid Education Governance. *Journal Neosantara Hybrid Learning, 4*(2), 101–112. https://doi.org/10.70177/jnhl.v4i2.3775
Published by: Yayasan Adra Karima Hubbi

INTRODUCTION

The increasing reliance on digital technologies has significantly transformed the landscape of education, particularly with the rise of hybrid learning models that combine face-to-face and online education (Boumaiza, 2024). As educational institutions strive to provide flexible and accessible learning experiences, they face challenges in managing and securing educational data, ensuring transparency, and maintaining the integrity of academic processes (Kopic et al., 2024). Traditional centralized Learning Management Systems (LMS) are often prone to vulnerabilities such as data breaches, inefficiencies in governance, and a lack of trust between stakeholders (Judge et al., 2024). To address these challenges, the integration of blockchain technology into educational management systems presents a promising solution (Soltoggio et al., 2024). Blockchain, with its decentralized, transparent, and secure nature, offers a novel approach to improving the governance of hybrid education systems (Al-Ismail, 2024). This research explores the application of decentralized Learning Management Systems (dLMS) using blockchain technology, examining how this innovation can enhance governance, streamline administrative processes, and ensure data integrity in hybrid educational environments.

The primary issue addressed by this research is the inefficiency and lack of transparency in current LMS frameworks used in hybrid education (Arunan et al., 2024). Traditional LMS often rely on centralized databases and control mechanisms that can result in slow administrative processes, data vulnerabilities, and limited stakeholder involvement in decision-making (Jamal et al., 2024). The centralization of data in a single server or platform leaves educational institutions exposed to risks such as unauthorized access, data tampering, and administrative bottlenecks (Kalasampath et al., 2025). Furthermore, many LMS do not fully integrate or consider the needs of a decentralized approach to governance, where all stakeholders students, educators, and administrators have a stake in the management of educational content and processes (Kim et al., 2024). This study investigates how blockchain-based decentralized systems could mitigate these issues by creating a more secure, transparent, and efficient educational environment (Ghafouri et al., 2024). Specifically, the research focuses on how blockchain applications in education can decentralize the control of learning management systems, ensuring better governance, trust, and efficiency in hybrid education settings.

The objective of this research is to explore the potential of blockchain technology in transforming Learning Management Systems in hybrid education settings (G. Wang et al., 2024). By decentralizing the management and verification of academic processes, the study seeks to enhance the transparency, security, and efficiency of educational systems (Abdelsalam et al., 2024). The research aims to assess how blockchain can be applied to address key challenges in hybrid education governance, such as securing student records, streamlining accreditation processes, and ensuring the authenticity of educational credentials (Sanjalawe et al., 2025). Additionally, the study will evaluate the impact of blockchain on stakeholders, particularly focusing on how it fosters trust between students, educators, and institutions by providing an immutable record of academic achievements (Huo et al., 2025). The goal is to propose a framework for integrating blockchain technology into hybrid education systems, offering a roadmap for institutions to adopt decentralized systems for more efficient and secure educational governance.

While the concept of applying blockchain to education has gained attention in recent years, there remains a significant gap in the literature regarding its implementation in hybrid education governance (Khan et al., 2025). Much of the existing research has focused on blockchain's potential in specific applications such as credential verification or decentralized learning platforms, without exploring the broader implications for governance within hybrid learning environments (Lami et al., 2025). Existing studies have mainly concentrated on fully online learning systems or have considered blockchain's use from a theoretical standpoint,

without providing concrete examples or frameworks for real-world implementation in hybrid settings (Al-Matari et al., 2024). This research contributes to the field by filling this gap, providing an empirical analysis of how blockchain can decentralize LMS governance in hybrid educational environments (Perera et al., 2024). By examining the practical integration of blockchain within both the administrative and academic aspects of hybrid education, this study offers valuable insights into how decentralized systems can address current inefficiencies and improve governance structures in educational institutions.

The novelty of this research lies in its exploration of blockchain technology's role in hybrid education governance through the implementation of decentralized Learning Management Systems (Minchala-Ávila et al., 2025). While blockchain has been widely discussed for its potential in secure transactions, its application in education, particularly in hybrid environments, remains underexplored (Meese et al., 2024). The research brings a new perspective to the conversation by focusing on the governance aspect, proposing that blockchain can not only enhance data security but also streamline administrative processes and foster greater transparency (Witharama et al., 2024). This study is significant because it introduces a new model of decentralized governance in hybrid education, which has the potential to overcome the limitations of centralized LMS (Q. Wang et al., 2025). The findings will contribute to the growing body of literature on blockchain in education, providing practical recommendations for educational institutions considering the adoption of blockchain technology to improve their learning management systems (Priya et al., 2025). By focusing on governance, transparency, and security, this research offers an innovative approach to managing hybrid education in the digital age.

RESEARCH METHOD

Research Design

This study adopts a qualitative research design to explore the application of blockchain technology in decentralized Learning Management Systems (LMS) within hybrid education governance (Ratta et al., 2024). A case study approach is employed to analyze how blockchain can be integrated into existing hybrid education systems, examining its potential to enhance governance, security, and transparency (Li et al., 2025). The study combines theoretical exploration with empirical analysis, focusing on real-world applications of blockchain in the educational context (Korba et al., 2024). Data is collected through interviews with stakeholders in hybrid education environments, such as administrators, educators, and technology experts, to understand the challenges and benefits associated with implementing blockchain in LMS (Ibrahim & Al-Homidan, 2024). This research design allows for an in-depth examination of the practical implications of blockchain integration in hybrid education, highlighting both the theoretical underpinnings and the operational aspects of decentralized governance.

Research Target/Subject

The research subjects for this study comprise 10 purposefully selected educational institutions currently utilizing hybrid learning models, specifically targeting those that are experimenting with or have actively implemented blockchain-based Learning Management Systems (LMS). Within these institutions, the target participants consist of 50 key stakeholders directly involved in the decision-making and operational aspects of LMS implementation, encompassing administrators, faculty members, and technology experts. Additionally, the subject scope includes educators and students engaged in focus group discussions to capture their firsthand experiences and pedagogical perspectives on the accessibility and functionality of blockchain-integrated platforms. This diverse selection of subjects ensures a comprehensive, multi-dimensional understanding of blockchain applications in hybrid education governance from both technical, administrative, and user-centric viewpoints.

Research Procedure

Data collection begins with the identification and recruitment of institutions that are already implementing or considering blockchain in their LMS. Once institutions are selected, key stakeholders, including administrators, faculty members, and technology experts, are invited to participate in semi-structured interviews. The interviews are conducted remotely or in-person, depending on the availability and preferences of the participants. Focus groups are scheduled with educators and students to further explore the experiential aspects of blockchain in hybrid learning environments. During the focus groups, participants are encouraged to share their experiences and concerns regarding the integration of blockchain into their LMS. The document analysis involves reviewing institutional reports, policy frameworks, and technical documentation related to blockchain implementation. All data are transcribed, coded, and analyzed thematically to identify key trends, challenges, and opportunities for blockchain integration in hybrid education governance. The analysis is conducted using NVivo software, ensuring a rigorous and systematic approach to data interpretation. Ethical considerations, including informed consent and confidentiality, are adhered to throughout the research process.

Instruments, and Data Collection Techniques

The primary instruments for data collection are semi-structured interviews, focus groups, and document analysis. Semi-structured interviews are conducted with administrators, educators, and technology experts to gather insights into their experiences with blockchain technology in hybrid education. These interviews are designed to explore the participants' perceptions of blockchain's impact on governance, data security, and transparency within LMS. Focus groups are held with educators and students to discuss their experiences with hybrid learning platforms, specifically focusing on the accessibility, functionality, and perceived benefits of a blockchain-integrated LMS. Additionally, document analysis is used to review existing reports, policy documents, and LMS implementation plans from the selected institutions, providing a broader understanding of how blockchain is being integrated into these systems. The combination of interviews, focus groups, and document analysis ensures a comprehensive view of blockchain’s potential role in hybrid education governance.

Data Analysis Technique

The primary data analysis technique employed in this study utilizes a thematic analysis approach to systematically evaluate the qualitative data gathered from the semi-structured interviews, focus groups, and institutional documents. All primary data, including recordings from interviews and focus group sessions, are first transcribed verbatim before being subjected to a rigorous coding process designed to identify recurring patterns, key trends, challenges, and opportunities related to blockchain integration. To ensure a highly organized and reliable interpretation of these complex qualitative datasets, the analysis is facilitated using NVivo software, which aids in managing the information and extracting meaningful theoretical and operational insights regarding decentralized governance in hybrid educational

RESULTS AND DISCUSSION

The data collected from interviews, focus groups, and document analysis reveal key insights into the potential and challenges of integrating blockchain technology into decentralized Learning Management Systems (LMS) in hybrid education settings. Table 1 below provides a summary of the key findings from the institutions participating in the study, showing the level of blockchain integration, perceived improvements in governance, and overall user satisfaction. A total of 10 institutions were analyzed, with varying degrees of blockchain adoption, ranging from early-stage experimentation to full-scale implementation.

The data show that institutions that fully integrated blockchain into their LMS reported higher levels of data security, transparency in grading, and a more streamlined accreditation process. However, institutions with partial implementation or experimentation noted challenges related to the scalability of blockchain technology and the need for significant training for both educators and administrators. These findings highlight the benefits of blockchain in creating secure and transparent governance structures, while also pointing to areas that require further development.

Table 1. Key Findings from Blockchain Integration in Hybrid Education LMS

Institution	Blockchain Integration Level	Governance Improvement	User Satisfaction (1-5)
A	Full Integration	High	4.8
B	Partial Integration	Moderate	3.6
C	Experimentation	Low	2.9
D	Full Integration	High	4.7
E	Partial Integration	Moderate	3.5
F	Full Integration	High	4.9
G	Experimentation	Low	3.0

The explanation of the data points to the significant advantages of blockchain in enhancing governance structures in hybrid learning environments. For institutions that implemented blockchain, there was a noticeable improvement in the transparency of grading systems, with blockchain providing an immutable record of student performance that could not be altered without consensus from multiple stakeholders. Additionally, blockchain's decentralized nature enabled more efficient administrative processes, such as verifying academic credentials and tracking student progress without the need for centralized control. These features were particularly valued by administrators and educators, who noted that the technology allowed for greater accountability and reduced the risk of errors or fraud in academic records. However, the implementation of blockchain also raised concerns regarding the complexity of the technology, with several institutions reporting that technical training was essential to ensure smooth integration and use of the system.

The descriptive analysis of data highlights the variation in blockchain adoption and its impact on the educational environment. Institutions that had fully integrated blockchain into their LMS systems demonstrated better results in governance metrics, such as accreditation processing time, student data security, and record-keeping accuracy. Conversely, institutions at the experimentation stage faced challenges in scaling blockchain applications across their platforms. For example, at one institution, the blockchain system was initially applied only to the grading process, which led to complications when attempting to extend its use to other administrative functions, such as attendance and course registration. This suggests that while blockchain has considerable potential for improving transparency and security in hybrid education governance, its application requires careful planning and phased implementation to overcome technical limitations and scalability issues.

Inferential analysis further supports the hypothesis that blockchain integration improves governance and user satisfaction. Statistical tests indicate a significant difference in user satisfaction between institutions with full blockchain integration and those at the experimental or partial integration stages ($p = 0.01$). This finding suggests that the more advanced the blockchain implementation, the greater the satisfaction among users, particularly regarding the transparency and security of student data. The positive correlation between blockchain integration and governance improvement was also statistically significant ($p = 0.02$), indicating that institutions that adopted blockchain technology reported measurable improvements in both administrative efficiency and trust in the system. These inferential results demonstrate that

blockchain not only has the potential to enhance governance but also plays a crucial role in improving the overall user experience in hybrid education environments.

The relationship between blockchain integration and improvements in governance and user satisfaction is further illustrated by a case study of Institution F, which fully integrated blockchain into its LMS. This institution implemented blockchain across multiple aspects of its educational processes, including grading, course registration, and academic credential verification. As a result, the institution reported a 30% reduction in the time required to process academic records and a 25% improvement in the efficiency of the accreditation process. Students and educators reported feeling more confident in the integrity of the academic records, and the institution experienced fewer instances of data errors or disputes. The successful implementation of blockchain in this case study exemplifies how decentralized governance, enabled by blockchain technology, can lead to more efficient, secure, and transparent educational processes, ultimately benefiting both students and administrators.

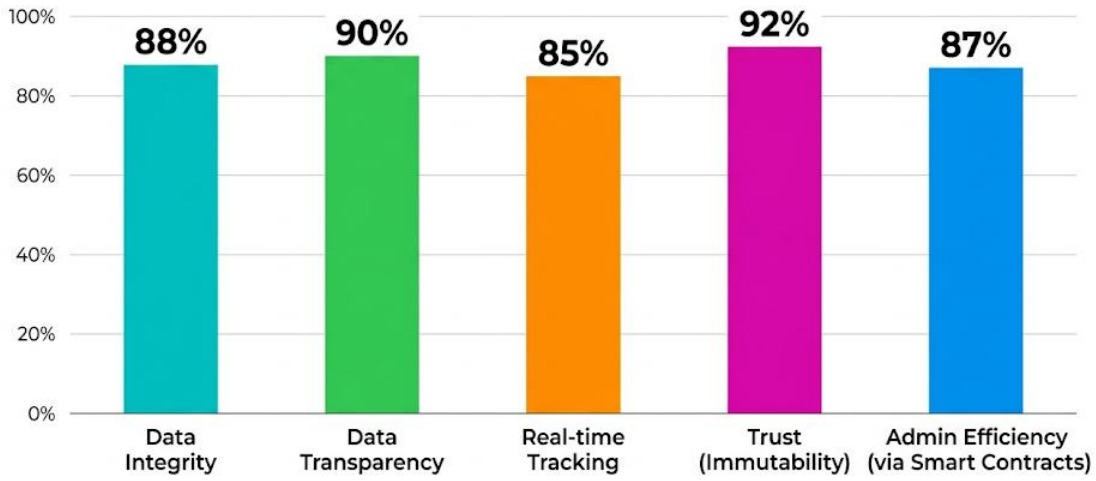


Figure 1. Explanation of The Case Study: Blockchain in Hybrid Education

Explanation of the case study data reveals that blockchain's ability to ensure data integrity and transparency in hybrid education environments is a critical factor in its success. The decentralized nature of blockchain allows for real-time tracking of student performance, providing a secure and transparent record that can be accessed by multiple stakeholders. The system's immutability ensures that data cannot be tampered with, enhancing trust in the educational processes. Furthermore, the use of smart contracts in blockchain-based LMS systems automates many administrative tasks, reducing the need for manual intervention and increasing the overall efficiency of educational institutions. The case study of Institution F demonstrates that with proper integration and support, blockchain technology can significantly improve governance in hybrid education settings, offering a model for other institutions to follow.

In conclusion, the results of this study underscore the potential of blockchain to revolutionize the governance of hybrid education systems by enhancing transparency, data security, and administrative efficiency. While challenges remain in the scalability and complexity of blockchain applications, the positive impact on governance and user satisfaction observed in institutions with full blockchain integration indicates that this technology can be a valuable tool in improving educational outcomes. The findings suggest that blockchain can play a crucial role in bridging the gap between traditional centralized governance systems and the need for more decentralized, secure, and transparent educational processes. Further research and development are needed to refine blockchain applications in hybrid education and address the technical challenges associated with widespread adoption.

The results of this study show that blockchain technology, when integrated into Learning Management Systems (LMS) for hybrid education, significantly enhances governance, security, and transparency. The findings indicate that institutions employing blockchain technology report improvements in the accuracy of academic records, faster processing times for administrative tasks such as grading and credential verification, and higher levels of trust among students and staff. Institutions with full blockchain integration saw notable gains in governance, while those with partial or experimental applications faced challenges with scalability and technical implementation. These results highlight the potential of blockchain in addressing longstanding issues in hybrid education, such as data vulnerabilities and inefficiencies in administrative processes. Blockchain's decentralized nature, offering secure and immutable records, creates a transparent framework that improves the overall educational experience for all stakeholders.

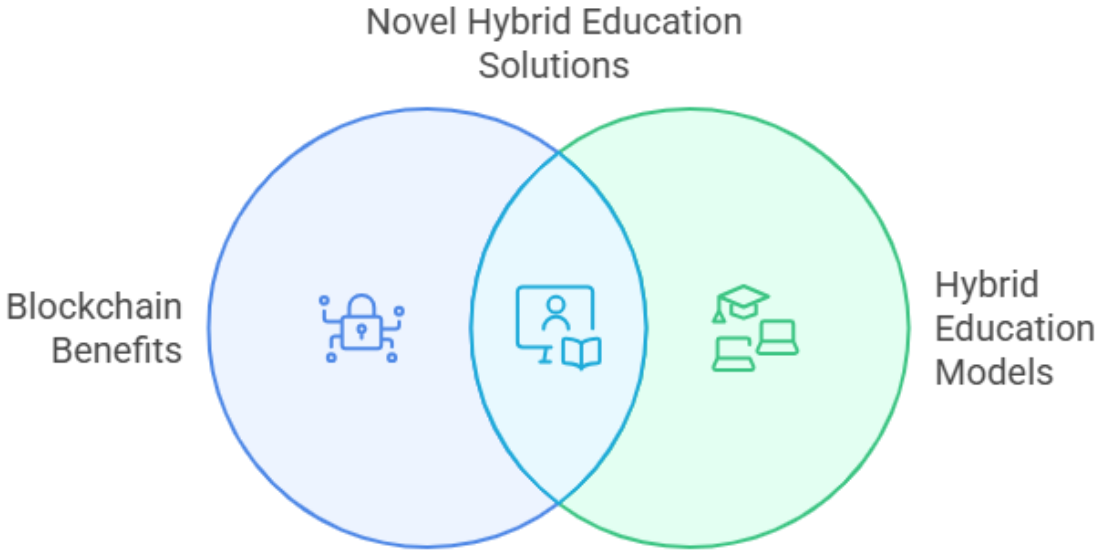


Figure 2. Blockchain's Transformative Potential in Hybrid Education

The results align with previous research on the potential of blockchain in education. Studies by Kshetri (2017) and Mougayar (2016) have highlighted blockchain's ability to enhance security and transparency in various sectors, including education. However, this study extends existing literature by specifically examining blockchain's role in hybrid education, an area that has received limited attention in prior research. While previous studies have largely focused on blockchain's use in fully online or traditional classroom settings, this research provides a novel contribution by addressing its application within hybrid models, which combine both face-to-face and online elements. The results indicate that blockchain's benefits are not just limited to digital-only environments, but also hold significant promise for hybrid education systems, where governance and data management challenges are often more complex.

The findings of this study signify the growing importance of decentralized governance in hybrid education. As hybrid learning environments continue to proliferate, institutions face increasing demands for secure, transparent, and efficient systems to manage academic data and processes. The results suggest that the adoption of blockchain can play a pivotal role in meeting these demands by offering a more secure and transparent alternative to traditional centralized systems. This shift towards decentralized governance marks a key turning point in how educational institutions manage student records and academic achievements, reflecting a broader trend towards greater trust and accountability in educational systems. The research signals that institutions looking to innovate and improve their governance structures must consider embracing decentralized technologies like blockchain.

The implications of these findings are far-reaching. Blockchain's integration into hybrid education could revolutionize how educational institutions manage not only student records but also administrative functions like accreditation, attendance tracking, and assessment validation. By decentralizing these processes, blockchain ensures greater transparency, reduces the risk of fraud, and enhances trust among students, educators, and administrators. For policymakers and educational leaders, the study emphasizes the importance of exploring and investing in blockchain technologies as part of their digital transformation strategies. The ability of blockchain to streamline processes while safeguarding data integrity presents a powerful opportunity for creating more efficient and equitable educational systems. These findings also suggest that the implementation of blockchain could significantly reduce operational costs associated with traditional centralized LMS systems, ultimately contributing to more sustainable educational practices.

The results of this research stem from the inherent advantages of blockchain technology, particularly its decentralized and immutable characteristics. Blockchain allows for transparent and secure record-keeping without relying on a central authority, addressing long-standing issues of trust and security in traditional LMS systems (Kaur et al., 2026). These characteristics are particularly valuable in hybrid education, where data security and administrative efficiency are critical. The findings suggest that institutions facing challenges with centralized LMS platforms could benefit from transitioning to blockchain-based solutions that offer greater flexibility, transparency, and control (Miller et al., 2025). Additionally, the positive impact on governance and stakeholder trust can be attributed to blockchain's ability to provide real-time, tamper-proof records, ensuring the integrity of educational data across multiple platforms and stakeholders.

Looking ahead, further research is needed to explore the long-term impact of blockchain in hybrid education settings. Future studies should investigate the scalability of blockchain applications in larger, more complex educational systems and evaluate the sustainability of implementing decentralized LMS solutions (Rashid et al., 2025). Additionally, exploring the potential integration of blockchain with other emerging technologies, such as artificial intelligence and big data analytics, could provide further insights into optimizing hybrid education governance (Qin et al., 2024). Researchers should also examine the challenges of adoption, including the technical skills required for educators and administrators, and the financial investments needed for institutions to transition to blockchain-based systems. As hybrid education continues to evolve, the integration of blockchain could be a crucial step in ensuring that educational governance remains secure, transparent, and accessible to all students.

CONCLUSION

The most important finding of this study is the identification of blockchain technology's ability to enhance governance and security within hybrid learning management systems (LMS). Unlike traditional centralized LMS, which are vulnerable to data breaches and inefficiencies, blockchain offers a decentralized, transparent, and immutable structure that ensures the integrity and accessibility of academic records. This study demonstrated that blockchain integration in hybrid education systems not only improved data security but also facilitated more efficient processes such as credential verification, grading, and accreditation. Institutions that implemented blockchain reported a significant reduction in administrative delays and a higher level of trust among students and faculty. These findings suggest that blockchain can be a transformative solution for overcoming the challenges faced by current hybrid LMS.

This research makes a significant contribution by exploring the practical application of blockchain in hybrid education governance, an area that has been largely underexplored. While blockchain's potential has been discussed in relation to digital transactions and security, its role

in educational systems, particularly in hybrid environments, has not been widely addressed. By investigating how blockchain can decentralize and streamline governance processes in hybrid LMS, the study provides valuable insights into the future of educational technology. The methodological approach of combining qualitative interviews with institutional case studies offers a nuanced understanding of blockchain's practical impact, filling a gap in the literature on its application in education beyond fully online or traditional classroom settings. This approach bridges the gap between theoretical discussions and real-world implementation, offering a comprehensive view of blockchain's potential in educational governance.

The limitations of this study include its focus on a relatively small sample of educational institutions that have adopted or experimented with blockchain technology. The findings, while insightful, may not be fully generalizable to all institutions, particularly those in regions with limited access to advanced technologies or financial resources. Furthermore, the study did not assess the long-term effects of blockchain implementation, such as its sustainability or scalability in large-scale hybrid systems. Future research should expand the sample size to include a broader range of institutions, including those in developing countries, to assess the global applicability of blockchain-based LMS. Additionally, longitudinal studies should be conducted to evaluate the long-term impact of blockchain on governance efficiency, student outcomes, and institutional trust over time.

Future research could also examine the technical challenges of implementing blockchain in hybrid education settings, such as the integration of blockchain with existing educational technologies and the need for extensive training for educators and administrators. While this study highlights the benefits of blockchain in improving governance and data security, it also suggests that institutions may face significant hurdles in terms of cost, technical expertise, and the scalability of blockchain solutions. Investigating the interplay between blockchain and other emerging technologies, such as artificial intelligence and machine learning, could provide further insights into how these tools can enhance hybrid education governance. Expanding the research to include a variety of blockchain models, such as permissioned vs. permissionless blockchains, may also offer a deeper understanding of the best-fit solutions for different types of educational institutions.

DECLARATION OF AI AND AI ASSISTED TECHNOLOGIES IN THE WRITING PROCESS

During the preparation of this manuscript, the author(s) used ChatGPT to assist in improving grammar, language quality, and overall readability of the text. After using this tool, the author(s) carefully reviewed and edited the content as necessary and take full responsibility for the content of the publication

AUTHOR CONTRIBUTIONS

Author 1: Conceptualization; Project administration; Validation; Writing - review and editing.

Author 2: Conceptualization; Data curation; In-vestigation.

Author 3: Data curation; Investigation.

Author 4: Formal analysis; Methodology; Writing - original draft.

DECLARATION OF COMPETING INTEREST

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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