

A Study on the Influence of the Blockchain-Based Academic Credentialing System and Digital Trust in the Education Ecosystem on Educational Governance Transparency through Data Integrity Assurance and Institutional Accountability Mechanism

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Abstract

Digital transformation has fundamentally reshaped educational governance by enhancing administrative efficiency, improving data management, and facilitating the issuance of academic credentials. However, the increasing reliance on digital technologies has also introduced challenges related to data manipulation, credential fraud, privacy protection, and institutional accountability. This study investigates the influence of the Blockchain-Based Academic Credentialing System and Digital Trust in the Education Ecosystem on Educational Governance Transparency, while examining the mediating roles of Data Integrity Assurance and Institutional Accountability Mechanism. This research employed a quantitative explanatory research design using a cross-sectional survey involving 250 undergraduate and graduate students at Universitas Bina Bangsa, Indonesia. Data were analyzed using Partial Least Squares–Structural Equation Modeling (PLS-SEM). The findings indicate that the Blockchain-Based Academic Credentialing System significantly improves Data Integrity Assurance and Institutional Accountability Mechanism but does not directly influence Educational Governance Transparency. Similarly, Digital Trust significantly strengthens Data Integrity Assurance and Institutional Accountability Mechanism but has no direct impact on governance transparency. Furthermore, Data Integrity Assurance does not significantly affect Educational Governance Transparency, whereas Institutional Accountability Mechanism emerges as the strongest determinant of transparency and serves as the only significant mediator in the proposed model. These findings suggest that technological innovation alone is insufficient to improve educational governance transparency. Instead, blockchain technology and digital trust generate meaningful governance outcomes only when supported by effective institutional accountability mechanisms. The study contributes to the advancement of Information Systems Success Theory, Institutional Theory, and Digital Governance literature by demonstrating that organizational governance mechanisms constitute the primary pathway through which digital transformation enhances transparency in higher education.

Keywords: – Blockchain, Credentialing System, Digital Trust, Ecosystem, Data Integrity

INTRODUCTION

Digital transformation has fundamentally reshaped nearly every aspect of educational governance, including academic data management, administrative processes, assessment systems, and the issuance of academic credentials. Higher education institutions worldwide have increasingly adopted digital technologies to improve service efficiency, enhance decision-making transparency, and strengthen institutional accountability. Nevertheless, the rapid expansion of digitalization has simultaneously introduced new challenges, including academic data manipulation, diploma fraud, personal data breaches, and limited interoperability among educational information systems (UNESCO, 2023; OECD, 2023).

One of the most prominent technological innovations attracting considerable attention in recent years is the implementation of blockchain technology in academic credentialing systems. Blockchain offers several distinctive characteristics, including decentralization, immutability, transparency, and real-time data verification, enabling every academic transaction to be permanently recorded and highly resistant to manipulation (Casino et al., 2019; Kumar & Tripathi, 2022). Within higher education, blockchain implementation extends beyond accelerating diploma and certificate verification; it also aims to establish educational governance systems that are more transparent, efficient, and trustworthy (Alammary et al., 2021).

Despite its technological advantages, the successful implementation of blockchain in education depends not only on technological sophistication but also on users' confidence in digital technologies. Digital trust represents a fundamental factor influencing users' willingness to adopt and continuously utilize digital systems. It reflects individuals' confidence that digital technologies adequately protect information security, preserve user privacy, ensure system reliability, and operate according to ethical principles and sound governance practices (Organisation for Economic Co-operation and Development [OECD], 2022). Without sufficient digital trust, blockchain adoption may encounter resistance from students, faculty members, and institutional administrators.

From the perspective of educational governance, transparency constitutes one of the essential pillars of good governance. Transparency enables stakeholders to access accurate, reliable, and timely information, thereby improving institutional decision-making quality (World Bank, 2023). Greater transparency is also expected to reduce administrative misconduct, strengthen public confidence, and enhance institutional reputation.

However, the relationships among Blockchain-Based Academic Credentialing Systems, Digital Trust, and Educational Governance Transparency remain insufficiently understood. Previous studies have predominantly examined blockchain implementation from technical perspectives, such as information security, system efficiency, and technological interoperability (Alammary et al., 2021; Kumar & Tripathi, 2022). Other studies have focused primarily on users' trust in digital services without integrating institutional governance mechanisms as outcomes of technological implementation (OECD, 2022). Consequently, research simultaneously integrating technological capability, digital trust, governance quality, and organizational mechanisms into a comprehensive conceptual framework remains limited.

Moreover, prior empirical findings reveal inconsistent evidence regarding the direct influence of digital technology implementation on organizational transparency. Several studies report that digital technologies significantly improve transparency and accountability, whereas others argue that these benefits emerge only when organizations establish governance mechanisms capable of ensuring data integrity and institutional accountability (UNESCO, 2023; OECD, 2023). These inconsistencies suggest that the

relationship between technological implementation and governance transparency is likely to be indirect rather than direct, operating through specific mediating mechanisms.

Drawing upon the Information Systems Success Theory (DeLone & McLean), Institutional Theory, and Digital Governance perspectives, this study proposes two mediating variables: Data Integrity Assurance and Institutional Accountability Mechanism. Data Integrity Assurance refers to the system's capability to maintain the accuracy, consistency, and security of academic information throughout the data lifecycle. Institutional Accountability Mechanism represents an organization's ability to establish transparent procedures, monitoring systems, and accountability practices for all stakeholders. These constructs are expected to explain how blockchain implementation and digital trust translate into greater educational governance transparency.

Based on the identified research gaps, this study offers several important contributions. First, it integrates two major determinants—Blockchain-Based Academic Credentialing System and Digital Trust in the Education Ecosystem—within a comprehensive research model. Second, it develops a dual-mediation framework involving Data Integrity Assurance and Institutional Accountability Mechanism, both of which have rarely been examined simultaneously in digital education research. Third, it positions Educational Governance Transparency as the primary strategic outcome of blockchain implementation, thereby extending existing literature that has largely emphasized technological rather than governance-related outcomes.

Accordingly, this study aims to examine the effects of the Blockchain-Based Academic Credentialing System and Digital Trust in the Education Ecosystem on Educational Governance Transparency, both directly and indirectly through Data Integrity Assurance and Institutional Accountability Mechanism. The findings are expected to contribute to the theoretical development of digital education governance while providing practical recommendations for higher education institutions, policymakers, and information system developers in designing secure, transparent, and accountable academic credentialing ecosystems.

The rapid advancement of digital transformation has encouraged educational institutions to adopt academic credentialing systems that are more secure, efficient, and globally verifiable. Among the emerging technologies addressing these needs, blockchain has received considerable attention. Blockchain is a distributed ledger technology that enables decentralized, immutable, transparent, and cryptographically secured data storage. These characteristics make blockchain a robust foundation for managing digital academic credentials by reducing the risks of diploma fraud, academic record manipulation, and inefficiencies in credential verification (Smolenski, 2021).

Within higher education, a Blockchain-Based Academic Credentialing System refers to a digital platform for issuing, storing, distributing, and verifying academic credentials through blockchain technology, ensuring that academic records are permanently stored, securely protected, and independently verifiable without relying on a centralized authority (Park, 2021). Unlike conventional centralized databases, blockchain records every academic transaction across distributed networks, thereby preserving information integrity even when individual network nodes experience disruption.

Recent studies suggest that blockchain-enabled micro-credential systems offer several strategic advantages, including enhanced interoperability among educational institutions, faster certificate validation, and greater ownership of academic records by credential holders. Furthermore, Delgado-von-Eitzen et al. (2021), through a systematic review of blockchain applications in education, concluded that blockchain contributes not only to data security but also to improved transparency of academic governance, administrative efficiency, and stakeholder trust.

According to the Information Systems Success Theory developed by DeLone and McLean (2022), high-quality information systems improve information quality, increase user trust, and ultimately generate greater organizational benefits. Consequently, implementing blockchain as an academic credentialing system is expected to produce academic information that is more accurate, complete, consistent, and verifiable, thereby strengthening both data integrity and institutional accountability.

Nevertheless, previous research indicates that blockchain implementation alone does not automatically enhance organizational transparency. Its effectiveness largely depends on institutional capabilities to maintain data integrity, establish accountability mechanisms, and foster digital trust among stakeholders (Park, 2021; Delgado-von-Eitzen et al., 2021).

Accordingly, the following hypotheses are proposed:

Trust constitutes a fundamental prerequisite for successful digital transformation in higher education. As educational institutions increasingly utilize cloud computing, artificial intelligence, blockchain, and digital learning platforms, they are expected not only to deploy advanced technologies but also to cultivate users' confidence regarding system security, reliability, privacy protection, and information integrity. This concept is commonly referred to as Digital Trust.

The OECD (2022) defines digital trust as the degree of confidence individuals and organizations place in digital technologies to operate securely, transparently, ethically, and in ways that effectively protect users' data and interests. Digital trust represents a critical driver of technology adoption because users are more willing to embrace digital systems when they believe that their information is adequately protected and managed responsibly.

Within higher education, Digital Trust in the Education Ecosystem reflects the confidence of students, faculty members, administrative personnel, policymakers, and society toward the digital infrastructure supporting academic activities. Such trust emerges through a combination of cybersecurity, privacy protection, digital service quality, policy transparency, and institutional capability to maintain the credibility of academic information (OECD, 2022; UNESCO, 2023).

Contemporary literature consistently demonstrates that digital trust is closely associated with effective digital governance. Organizations capable of cultivating digital trust tend to experience higher user participation, improved information exchange, stronger collaboration, and reduced resistance to technological innovation (Delgado-von-Eitzen et al., 2021). Likewise, Honkanen et al. (2021) emphasize that effective blockchain governance depends not only on technological design but also on transparent decision-making, accountability structures, and stakeholder trust. Consequently, digital trust is considered a strategic factor capable of strengthening both data integrity and institutional accountability.

Based on this theoretical synthesis, the following hypotheses are formulated:

Educational governance transparency represents one of the core principles of good governance, emphasizing openness, accountability, stakeholder participation, and accessibility of institutional decision-making processes. Transparency extends beyond merely publishing information; it also encompasses the accuracy, consistency, and traceability of educational administrative processes.

According to the World Bank (2023), transparency is an essential prerequisite for improving public service quality because it reduces information asymmetry, strengthens public trust, and enhances organizational legitimacy. Within higher education, transparency is reflected in the openness of academic data management, the validity of academic credentials, fair evaluation systems, and institutional accountability toward all stakeholders.

Blockchain technology provides substantial opportunities to strengthen educational transparency by recording academic transactions permanently, creating auditable records, and minimizing opportunities for manipulation (Smolenski, 2021). Nevertheless, empirical

studies indicate that transparency depends more heavily on organizational governance quality than on technological implementation alone.

Accordingly, Educational Governance Transparency is conceptualized in this study as the primary endogenous variable influenced by blockchain implementation, digital trust, data integrity assurance, and institutional accountability mechanisms.

Data Integrity Assurance refers to the guarantee that information remains accurate, complete, authentic, consistent, and protected from unauthorized modification throughout its entire lifecycle. Within educational information systems, data integrity serves as a critical foundation for institutional decision-making, policy formulation, and academic credential issuance.

Blockchain technology enables every data modification to be permanently recorded through cryptographic mechanisms, thereby increasing the reliability of academic information. Such systems substantially reduce opportunities for data manipulation while simultaneously providing transparent audit trails (Park, 2021; Delgado-von-Eitzen et al., 2021).

Information quality theory suggests that higher data integrity leads to greater user confidence in information systems. Therefore, this study conceptualizes Data Integrity Assurance as a mediating mechanism linking blockchain implementation with educational governance transparency.

The corresponding hypothesis is formulated as follows:

Institutional accountability refers to an organization's ability to justify its decisions, policies, and resource utilization through transparent, auditable, and well-documented procedures. Within modern educational governance, accountability constitutes one of the primary indicators of effective governance.

According to Honkanen et al. (2021), effective blockchain governance should be established upon clearly defined organizational roles, accountability procedures, decision-making rights, and comprehensive monitoring systems. Without these governance mechanisms, the technological advantages of blockchain cannot generate optimal organizational benefits.

The implementation of blockchain-based academic credentialing systems enables higher education institutions to establish more effective auditing processes because every academic transaction can be monitored in real time and cannot be modified without network consensus. Consequently, institutional accountability is strengthened while educational governance transparency is simultaneously enhanced (Samangan et al., 2025).

Therefore, Institutional Accountability Mechanism is proposed as a mediating variable connecting blockchain implementation and digital trust with improvements in educational governance transparency.

The corresponding hypothesis is proposed as follows:

Adaptive Governance Theory argues that governance structures influence policy outcomes through intermediate governance processes rather than solely through direct effects (Folke et al., 2021). In this study, Adaptive Governance Capacity and Green Policy Implementation Effectiveness represent key mechanisms through which Climate-Resilient Institutional Design and Interagency Policy Coordination influence Green Transition Performance.

Previous studies suggest that resilient institutions and coordinated governance arrangements improve sustainability outcomes indirectly by strengthening adaptive capacity and implementation effectiveness (Djalante et al., 2023; Kivimaa et al., 2024; Gupta et al.,

2023). However, empirical findings remain fragmented, particularly regarding the simultaneous mediating roles of adaptive governance and implementation effectiveness.

Within the proposed model, Blockchain-Based Academic Credentialing System and Digital Trust in the Education Ecosystem are positioned as exogenous variables representing technological and digital environmental dimensions. Both constructs are expected to improve Data Integrity Assurance by providing secure, reliable, and verifiable information systems. Simultaneously, they are hypothesized to strengthen Institutional Accountability Mechanism through greater administrative transparency, enhanced traceability of academic transactions, and more effective auditing procedures.

Furthermore, Data Integrity Assurance and Institutional Accountability Mechanism function as mediating variables explaining how technological innovation generates improvements in Educational Governance Transparency. In other words, this study assumes that blockchain technology and digital trust do not automatically produce transparent educational governance. Instead, their benefits are realized through enhanced academic information quality and stronger institutional accountability.

Overall, the proposed conceptual model comprises twelve research hypotheses, including eight direct effects and four indirect effects involving dual mediation mechanisms. This framework is expected to provide a more comprehensive understanding of how transparency in educational governance emerges within blockchain-enabled digital education ecosystems.

METHODS

Research Design and Study Area

This study employed a quantitative explanatory research design to investigate the relationships among the Blockchain-Based Academic Credentialing System (BACS), Digital Trust in the Education Ecosystem (DT), Data Integrity Assurance (DIA), Institutional Accountability Mechanism (IAM), and Educational Governance Transparency (EGT). An explanatory approach was selected because the primary objective was to examine causal relationships among latent constructs and to evaluate the proposed theoretical framework through empirical evidence.

A cross-sectional survey was conducted to collect data from respondents at a single point in time. This design is widely adopted in digital governance and information systems research because it enables researchers to evaluate users' perceptions regarding technology adoption, institutional governance, and organizational outcomes efficiently and systematically. Research was done in Bina Bangsa university..

Population, Sampling Technique, and Data Collection

The population of this study comprised undergraduate and graduate students enrolled at Universitas Bina Bangsa, Indonesia, who had experience using digital academic information systems, including online academic services, digital learning platforms, and electronic academic credential systems.

A purposive sampling technique was employed to ensure that respondents possessed sufficient experience with digital academic services. Participants were required to meet the following criteria:

1. be actively enrolled as university students;
2. have experience using the institution's digital academic information systems;
3. understand the use of online academic services; and
4. voluntarily agree to participate in the research.

Based on these criteria, 250 valid questionnaires were collected and included in the final analysis. This sample size satisfies the minimum requirements recommended for Partial

Least Squares–Structural Equation Modeling (PLS-SEM) and provides sufficient statistical power for estimating complex structural relationships among latent variables.

Measurement Instrument and Variables

All research constructs were operationalized using measurement indicators adapted from established studies in blockchain adoption, digital trust, information systems, and educational governance. Minor wording modifications were made to ensure contextual relevance to higher education while preserving the conceptual meaning of the original instruments.

Each construct was measured using multiple reflective indicators evaluated on a five-point Likert scale, ranging from:

1 = Strongly Disagree to 5 = Strongly Agree.

The latent constructs included:

1. Blockchain-Based Academic Credentialing System (BACS) as the first exogenous variable;
2. Digital Trust in the Education Ecosystem (DT) as the second exogenous variable;
3. Data Integrity Assurance (DIA) as the first mediating variable;
4. Institutional Accountability Mechanism (IAM) as the second mediating variable; and
5. Educational Governance Transparency (EGT) as the endogenous variable.

Data Analysis Procedure

The collected data were analyzed using Partial Least Squares–Structural Equation Modeling (PLS-SEM) with SmartPLS 4 software. PLS-SEM was selected because it is appropriate for predictive research models involving multiple latent variables, mediation effects, and complex causal relationships.

Therefore, this study proposes the following mediation hypotheses:

H1: Blockchain-Based Academic Credentialing System positively influences Data Integrity Assurance.

H2: Blockchain-Based Academic Credentialing System positively influences Institutional Accountability Mechanism.

H3: Blockchain-Based Academic Credentialing System positively influences Educational Governance Transparency.

H4: Digital Trust in the Education Ecosystem positively influences Data Integrity Assurance.

H5: Digital Trust in the Education Ecosystem positively influences Institutional Accountability Mechanism.

H6: Digital Trust in the Education Ecosystem positively influences Educational Governance Transparency.

H7: Data Integrity Assurance positively influences Educational Governance Transparency.

H8: Institutional Accountability Mechanism positively influences Educational Governance Transparency.

H10: *Adaptive Governance Capacity mediates the relationship between Climate-Resilient Institutional Design and Green Transition Performance.*

H11: *Green Policy Implementation Effectiveness mediates the relationship between Climate-Resilient Institutional Design and Green Transition Performance.*

H12: *Adaptive Governance Capacity mediates the relationship between Interagency Policy Coordination and Green Transition Performance.*

H13: *Green Policy Implementation Effectiveness mediates the relationship between Interagency Policy Coordination and Green Transition Performance.*

H14: *Green Policy Implementation Effectiveness mediates the relationship between Adaptive Governance Capacity and Green Transition Performance.*

Conceptual Framework of Adaptive Public Policy Governance for the Green Transition is presented in figure 1.

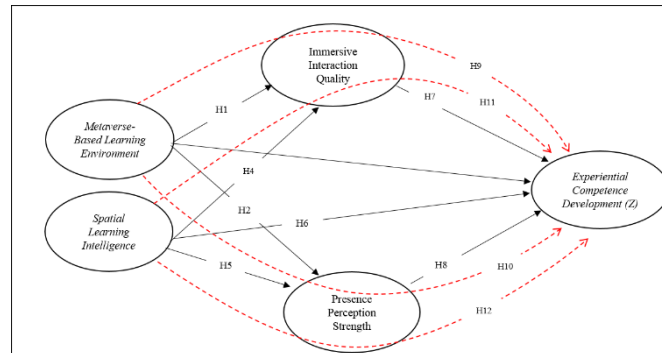


Figure 1. Research Design

Figure 1 presents the The conceptual framework of this study is developed by integrating four major theoretical perspectives: the Information Systems Success Model, the Technology–Organization–Environment (TOE) Framework, Institutional Theory, and Good Governance Theory. Collectively, these theories suggest that successful digital transformation depends not only on technological quality but also on organizational readiness, information quality, governance mechanisms, and users' trust in digital systems..

RESULTS

Structural Model and Hypothesis Testing

Hypothesis testing in this study was conducted using the Partial Least Squares–Structural Equation Modeling (PLS-SEM) approach through the bootstrapping procedure implemented in SmartPLS 4. The analysis examined both direct effects and indirect effects among the variables included in the proposed research model. The decision regarding each hypothesis was based on the path coefficient (β), t-statistic, and p-value. A hypothesis was considered supported when the t-statistic exceeded 1.96 and the p-value was less than 0.05 at the 5% significance level.

Table 1. Hypothesis Testing

	Original sample (O)	T statistics (O/STDEV)	P values
B-BACS -> DIA	0.168	2.786	0.005
B-BACS -> EGT	-0.029	0.854	0.393
B-BACS -> IAM	0.325	4.391	0.000
DIA -> EGT	-0.027	0.512	0.609
DTEE -> DIA	0.763	14.042	0.000
DTEE -> EGT	0.050	1.168	0.243
DTEE -> IAM	0.214	3.020	0.003
IAM -> EGT	0.919	57.106	0.000

Based on Table 1, five structural relationships were statistically significant, whereas three relationships were not. Of the eight direct-effect hypotheses examined, five hypotheses

(H1, H2, H4, H5, and H8) received empirical support, while the remaining three hypotheses (H3, H6, and H7) were not supported.

The results indicate that the Blockchain-Based Academic Credentialing System (B-BACS) has a positive and significant effect on Data Integrity Assurance ($\beta = 0.168$; $t = 2.786$; $p = 0.005$). This finding suggests that greater implementation of blockchain-based academic credentialing systems enhances the assurance of academic data integrity. Therefore, H1 is supported.

Furthermore, the Blockchain-Based Academic Credentialing System exerts a positive and significant influence on the Institutional Accountability Mechanism ($\beta = 0.325$; $t = 4.391$; $p < 0.001$). The path coefficient demonstrates that blockchain implementation contributes substantially to strengthening accountability mechanisms within educational institutions. Accordingly, H2 is supported.

In contrast, the direct effect of the Blockchain-Based Academic Credentialing System on Educational Governance Transparency is not statistically significant ($\beta = -0.029$; $t = 0.854$; $p = 0.393$). Although the relationship is negative, the coefficient is extremely small and lacks statistical significance. Therefore, H3 is rejected.

The analysis further reveals that Digital Trust in the Education Ecosystem (DTEE) has a strong positive and significant effect on Data Integrity Assurance ($\beta = 0.763$; $t = 14.042$; $p < 0.001$). This represents one of the largest coefficients in the structural model, indicating that digital trust plays a crucial role in enhancing academic data integrity. Consequently, H4 is supported.

Similarly, Digital Trust in the Education Ecosystem positively and significantly influences the Institutional Accountability Mechanism ($\beta = 0.214$; $t = 3.020$; $p = 0.003$). This finding suggests that increasing confidence in the digital education ecosystem contributes to stronger institutional accountability practices. Accordingly, H5 is supported.

However, the direct relationship between Digital Trust in the Education Ecosystem and Educational Governance Transparency is not statistically significant ($\beta = 0.050$; $t = 1.168$; $p = 0.243$). This result indicates that higher levels of digital trust alone are insufficient to directly improve educational governance transparency. Therefore, H6 is rejected.

Likewise, Data Integrity Assurance does not have a significant effect on Educational Governance Transparency ($\beta = -0.027$; $t = 0.512$; $p = 0.609$). This finding implies that improving academic data integrity alone is insufficient to enhance governance transparency unless accompanied by effective organizational mechanisms. Consequently, H7 is rejected.

Conversely, the Institutional Accountability Mechanism demonstrates a strong positive and statistically significant influence on Educational Governance Transparency ($\beta = 0.919$; $t = 57.106$; $p < 0.001$). The exceptionally high path coefficient indicates that institutional accountability is the most dominant determinant of transparency in educational governance. Therefore, H8 is supported.

Overall, the direct-effect analysis demonstrates that improvements in educational governance transparency are not directly driven by either blockchain implementation or digital trust. Instead, transparency is primarily determined by the institution's capability to establish effective accountability mechanisms. These findings suggest that digital transformation in higher education requires not only technological innovation but also strong organizational governance as a fundamental prerequisite for achieving institutional transparency.

Mediasi analysis Indirect Effects

To examine the mediating roles of the proposed variables, an indirect effect analysis was conducted using the bootstrapping procedure in PLS-SEM. The results are presented in Table 2.

Table 2. Indirect Effects

	Original sample (O)	P values
DTEE -> IAM -> EGT	0.197	0.002
B-BACS -> DIA -> EGT	-0.004	0.630
DTEE -> DIA -> EGT	-0.020	0.613
B-BACS -> IAM -> EGT	0.299	0.000

The findings indicate that not all mediating variables function effectively in explaining the relationships between the exogenous and endogenous constructs. Of the four mediation hypotheses tested, only two hypotheses (H10 and H12) received empirical support, whereas H9 and H11 were not statistically supported.

The results reveal that Data Integrity Assurance does not mediate the relationship between the Blockchain-Based Academic Credentialing System and Educational Governance Transparency ($\beta = -0.004$; $t = 0.482$; $p = 0.630$). Accordingly, H9 is rejected.

In contrast, a different pattern emerges for the mediation pathway through the Institutional Accountability Mechanism. The analysis demonstrates that the Institutional Accountability Mechanism significantly mediates the effect of the Blockchain-Based Academic Credentialing System on Educational Governance Transparency ($\beta = 0.299$; $t = 4.314$; $p < 0.001$). Therefore, H10 is supported.

Similarly, Data Integrity Assurance does not mediate the relationship between Digital Trust in the Education Ecosystem and Educational Governance Transparency ($\beta = -0.020$; $t = 0.505$; $p = 0.613$), leading to the rejection of H11.

Conversely, the Institutional Accountability Mechanism significantly mediates the relationship between Digital Trust in the Education Ecosystem and Educational Governance Transparency ($\beta = 0.197$; $t = 3.035$; $p = 0.002$). Consequently, H12 is supported.

Overall, the mediation analysis demonstrates that the Institutional Accountability Mechanism is the only effective mediator in the proposed research model. By contrast, Data Integrity Assurance fails to explain the mechanisms through which blockchain implementation and digital trust contribute to educational governance transparency. These findings suggest that the success of digital transformation in higher education depends more on an institution's ability to establish accountable organizational systems than merely on improving the quality and integrity of academic data.

DISCUSSION

The Effect of the Blockchain-Based Academic Credentialing System on Data Integrity Assurance

The hypothesis testing results demonstrate that the Blockchain-Based Academic Credentialing System has a positive and statistically significant effect on Data Integrity Assurance, with a path coefficient (β) of 0.168, a t-statistic of 2.786, and a p-value of 0.005. Accordingly, the first hypothesis (H1) is supported. The positive coefficient indicates that more effective implementation of blockchain-based academic credentialing systems leads to higher levels of perceived academic data integrity among students. Although the magnitude of the effect is moderate, the findings confirm that blockchain implementation makes a meaningful contribution to improving the quality of academic data management.

From a conceptual perspective, blockchain possesses several distinctive characteristics, including immutability, distributed ledger architecture, consensus mechanisms, and cryptographic authentication, all of which ensure that academic transactions are permanently

recorded and highly resistant to manipulation. These characteristics enable educational institutions to maintain the consistency, authenticity, and security of academic records while minimizing the risk of unauthorized data modification. Consequently, blockchain serves not only as a technological innovation but also as an effective mechanism for strengthening academic information integrity.

These findings support the Information Systems Success Model proposed by DeLone and McLean (2003), which identifies system quality as a primary determinant of information quality. Within the context of this study, the Blockchain-Based Academic Credentialing System represents system quality, whereas Data Integrity Assurance reflects the quality of the resulting information. Therefore, the findings reinforce the argument that improvements in digital system quality through blockchain technology produce academic data that are more accurate, consistent, secure, and trustworthy.

The present findings are also consistent with those reported by Park (2021), who demonstrated that blockchain implementation enhances data security and reliability through decentralized storage mechanisms. Likewise, Delgado-von Eitzen et al. (2021) concluded that blockchain improves the authenticity of academic credentials while reducing the risk of educational document fraud. Similarly, Kumar and Tripathi (2022) found that blockchain technology contributes to stronger data integrity by providing transparent, verifiable, and tamper-resistant transaction records.

Nevertheless, the relatively smaller path coefficient compared with the effect of Digital Trust in the Education Ecosystem on Data Integrity Assurance ($\beta = 0.763$) suggests that improvements in data integrity are not determined solely by technological sophistication. Users' trust in the digital ecosystem also plays a crucial role. In other words, advanced technological capabilities must be complemented by strong user confidence to maximize the benefits of blockchain implementation.

From a practical standpoint, these findings imply that higher education institutions should not merely adopt blockchain technology as a platform for storing academic credentials. They must also ensure that the technology is supported by comprehensive information security standards, transparent verification procedures, and effective data governance policies capable of strengthening stakeholders' confidence in the integrity of academic information.

The Effect of the Blockchain-Based Academic Credentialing System on the Institutional Accountability Mechanism

The empirical results indicate that the Blockchain-Based Academic Credentialing System has a positive and statistically significant effect on the Institutional Accountability Mechanism, with a path coefficient (β) of 0.325, a t-statistic of 4.391, and a p-value of less than 0.001. Accordingly, the second hypothesis (H2) is supported. The magnitude of the coefficient suggests that blockchain implementation makes a substantial contribution to strengthening institutional accountability mechanisms.

These findings indicate that the use of blockchain in academic credential management enhances institutional accountability by increasing the transparency of administrative processes, improving the traceability of academic transactions, and facilitating comprehensive auditing of all activities recorded within the system. Every modification to academic data leaves a permanent digital audit trail, enabling institutions to justify administrative decisions more objectively and transparently.

The findings support Institutional Theory, as proposed by Scott (2022), which argues that organizations achieve legitimacy by meeting stakeholder expectations through accountable governance mechanisms. In the present study, blockchain functions as an instrument that strengthens institutional legitimacy by providing authentic, documented, and

verifiable digital evidence. Consequently, blockchain enhances not only technological capability but also organizational governance quality.

Furthermore, the findings are consistent with the Technology–Organization–Environment (TOE) Framework, which suggests that successful technology implementation depends on an organization's ability to integrate technological innovation into its operational processes and governance structures. This study demonstrates that the benefits of blockchain arise not only from its technological characteristics but also from the institution's capability to embed the technology within its organizational control mechanisms.

The present results are also consistent with the findings of Honkanen et al. (2021), who reported that blockchain implementation enhances organizational accountability through transparent and auditable digital record-keeping systems. Similarly, Casino et al. (2022) found that blockchain improves organizational governance by strengthening monitoring, reporting, and information verification mechanisms.

From a practical perspective, these findings suggest that investments in blockchain technology will generate greater organizational value when directed toward strengthening institutional accountability rather than merely digitizing administrative processes. Consequently, higher education institutions should complement technological implementation with well-designed operational procedures, comprehensive auditing systems, and integrated accountability frameworks that leverage blockchain technology effectively.

The Effect of Data Integrity Assurance on Educational Governance Transparency

The empirical findings indicate that Data Integrity Assurance does not have a statistically significant effect on Educational Governance Transparency, with a path coefficient (β) of -0.027 , a t -statistic of 0.512 , and a p -value of 0.609 . Consequently, the seventh hypothesis (H7) is not supported.

Although blockchain technology substantially improves the accuracy, consistency, and security of academic information, the findings demonstrate that these improvements alone are insufficient to enhance governance transparency. Educational governance transparency extends beyond technical data quality and encompasses institutional openness, accountable decision-making, stakeholder participation, and effective governance practices.

These findings imply that the integrity of academic data constitutes a necessary—but not sufficient—condition for achieving transparent educational governance. Institutions may possess highly reliable and secure information systems while still failing to establish transparent governance if appropriate accountability mechanisms are absent.

From the perspective of the Information Systems Success Model, information quality contributes to organizational performance only when supported by organizational processes capable of transforming high-quality information into effective managerial decisions. Therefore, ensuring data integrity alone cannot guarantee transparency without complementary governance mechanisms.

These findings differ from several previous studies that reported a positive relationship between data quality and organizational transparency. The discrepancy may be explained by differences in research context. In blockchain-enabled educational environments, transparency appears to depend more heavily on governance quality than on the technical characteristics of information systems.

Practically, higher education institutions should avoid concentrating exclusively on improving data quality while neglecting governance reform. Investments in digital infrastructure should be accompanied by organizational policies that strengthen accountability, transparency, and institutional oversight.

The Effect of the Institutional Accountability Mechanism on Educational Governance Transparency

The results reveal that the Institutional Accountability Mechanism exerts a strong positive and statistically significant effect on Educational Governance Transparency, with a path coefficient (β) of 0.919, a t-statistic of 57.106, and a p-value of less than 0.001. Accordingly, the eighth hypothesis (H8) is supported.

Among all structural relationships examined in this study, this represents the strongest effect, demonstrating that institutional accountability is the primary determinant of transparent educational governance. The exceptionally large coefficient indicates that transparency is achieved principally through accountable organizational practices rather than through technological innovation alone.

These findings strongly support Institutional Theory, which emphasizes that organizational legitimacy depends upon the existence of effective governance structures, transparent decision-making procedures, and accountable institutional practices. Blockchain technology and digital trust create opportunities for organizational improvement, but meaningful governance outcomes emerge only when institutions establish robust accountability mechanisms.

The findings are also consistent with the principles of Good Governance Theory, which identifies accountability as one of the essential pillars of transparent governance. Institutions that implement clear reporting procedures, effective monitoring systems, and comprehensive audit mechanisms are better positioned to provide transparent public services and maintain stakeholder confidence.

From a practical standpoint, the findings indicate that higher education institutions should prioritize organizational governance reforms alongside digital transformation initiatives. Investments in blockchain technology will generate sustainable governance benefits only when accompanied by clearly defined accountability structures, transparent operational procedures, and effective internal control systems.

The mediation analysis demonstrates that Data Integrity Assurance does not significantly mediate the relationships between either the Blockchain-Based Academic Credentialing System or Digital Trust in the Education Ecosystem and Educational Governance Transparency. In contrast, the Institutional Accountability Mechanism serves as a significant mediator in both structural pathways.

These findings suggest that blockchain technology and digital trust influence governance transparency indirectly by strengthening institutional accountability rather than merely improving information quality. The results highlight that organizational governance mechanisms represent the critical pathway through which technological innovation translates into improved governance outcomes.

Overall, the proposed research model confirms that technological capability alone does not guarantee transparent educational governance. Instead, transparency is achieved when technological innovation is embedded within accountable institutional systems capable of converting digital resources into effective governance practices.

CONCLUSION

Conclusion

This study examined the influence of the Blockchain-Based Academic Credentialing System and Digital Trust in the Education Ecosystem on Educational Governance Transparency, while evaluating the mediating roles of Data Integrity Assurance and the Institutional Accountability Mechanism.

The findings indicate that both the Blockchain-Based Academic Credentialing System and Digital Trust significantly enhance Data Integrity Assurance and the Institutional Accountability Mechanism. However, neither construct directly influences Educational Governance Transparency. Furthermore, Data Integrity Assurance does not significantly affect governance transparency and fails to mediate the relationships between the exogenous variables and transparency. In contrast, the Institutional Accountability Mechanism emerges as the strongest predictor of Educational Governance Transparency and serves as the only significant mediating variable within the proposed structural model.

These findings demonstrate that technological innovation alone is insufficient to improve governance transparency in higher education. Instead, the benefits of blockchain technology and digital trust can only be fully realized when educational institutions establish effective accountability mechanisms capable of supporting transparent, responsible, and well-governed administrative processes.

From a theoretical perspective, this study extends the Information Systems Success Theory, Institutional Theory, and Good Governance Theory by demonstrating that organizational governance mechanisms constitute the principal pathway through which digital transformation enhances transparency in educational institutions. From a practical perspective, the findings provide valuable guidance for policymakers and higher education administrators seeking to implement blockchain-based academic credentialing systems within accountable governance frameworks

Research Limitations

Several limitations should be acknowledged. First, the study was conducted at a single higher education institution, thereby limiting the generalizability of the findings to other institutional contexts. Second, the research employed a cross-sectional design, which captures respondents' perceptions at a single point in time and does not permit causal inference over extended periods. Third, the study focused primarily on students' perceptions, while excluding other important stakeholders such as faculty members, university administrators, policymakers, and employers.

Future studies should therefore incorporate multiple stakeholder groups and longitudinal research designs to provide a more comprehensive understanding of blockchain-enabled educational governance and its long-term organizational implications.

Suggestions and Directions for Future Research

Future research is encouraged to expand the proposed model by incorporating additional organizational and technological variables, including organizational readiness, digital leadership, technology acceptance, cybersecurity capability, and regulatory support. Comparative studies involving multiple universities or cross-national educational systems would also provide valuable insights into the contextual factors influencing blockchain implementation in higher education.

Moreover, future investigations may employ longitudinal designs to examine how blockchain adoption influences institutional governance over time. Integrating qualitative approaches or mixed-methods research could further enrich the understanding of stakeholder experiences, organizational challenges, and governance transformations associated with blockchain-based academic credentialing systems. Such studies would contribute to the development of more comprehensive theoretical frameworks and evidence-based policy recommendations for digital transformation in higher education.

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Conflict of interest

The authors declare that there are no conflicts of interest regarding the publication of this paper.

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