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BLOCKCHAIN-BASED INNOVATION AND ITS IMPACT ON SUSTAINABLE INSTITUTIONAL PERFORMANCE IN LIBYAN UNIVERSITIES

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ABSTRACT

This study aimed to assess the impact of blockchain-enabled innovation (dimensions: processes, services, and business models) on sustainable institutional performance (dimensions: economic, social, and environmental) in Libyan public universities, The study adopted a quantitative methodology with a deductive approach, grounded in the Dynamic Capabilities View (DCV) and Service-Dominant Logic (S-D logic). Primary data were collected through an electronic questionnaire distributed to a sample of academic and administrative leaders, faculty members, and IT specialists. Partial Least Squares Structural Equation Modeling (PLS-SEM) was employed using SmartPLS v4 to analyze the data and test the hypotheses. The findings revealed high measurement model quality in terms of reliability, internal consistency, and convergent and discriminant validity. The structural model assessment indicated a strong, positive, and statistically significant effect of blockchain-enabled innovation on sustainable institutional performance ($\beta = 0.865$, $t = 33.055$, $p < 0.001$). Furthermore, the model demonstrated substantial explanatory power, with blockchain-enabled innovation accounting for 74.9% of the variance in sustainable performance ($R^2 = 0.749$), alongside a large effect size ($f^2 = 2.983$). The PLSpredict results confirmed strong out-of-sample predictive relevance, with positive Q^2 values across all dimensions. The study concludes that integrating blockchain as a strategic pillar in university transformation plans is essential, along with implementing smart contracts and micro-credentials to enhance governance reliability and support the transition toward a sustainable green campus.

Keywords: *Blockchain Technology, Blockchain-Enabled Innovation, Sustainable Institutional Performance, Libyan Universities, Digital Transformation, Partial Least Squares Structural Equation Modeling (PLS-SEM)*

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INTRODUCTION

Blockchain technology has emerged as one of the most disruptive technologies, extending beyond financial applications to enhance the efficiency of administrative and academic processes (Ali et al., 2023). leaders in organizations adopt digital transformation initiatives to break away from traditional practices and patterns and to address competition to achieve digital leadership.(Emran & Elhony , 2024) . The core strength of this technology lies in its decentralization, transparency, and immutability, which collectively enhance the reliability of academic performance and reduce transaction costs (Singh et al., 2023). Blockchain-driven innovation is not limited to technical aspects; rather, it extends to the reengineering of university processes and services, leading to the development of more flexible and sustainable educational business models (Li et al., 2025). Despite the growing interest in this technology, a significant research gap remains regarding how such innovations can be translated into sustainable institutional performance that balances operational efficiency with social and environmental responsibility (Kouhizadeh et al., 2021). The need for this research is further reinforced by the critical role of blockchain-based governance in enhancing accountability and trust within educational systems (Ezzine et al., 2026). Emran and Elhony, in their study of AIin Libyan higher education institutions, conclude that "the implementation and adoption of artificial intelligence is inevitable in the education sector" (Emran & Elhony , 2024 , p .1248)

Drawing on the Dynamic Capabilities Theory, it is assumed that adopting blockchain-driven innovations in processes, services, and business models plays a fundamental role in advancing sustainable institutional performance (Esfahbodi & Sunmola, 2026). Accordingly, the present study seeks to examine the impact of blockchain-enabled innovation, across its three dimensions, on the sustainable performance of universities, thereby providing both a theoretical and practical framework for decision-makers in higher education institutions.

2. Previous Studies

Ezzine et al. (2026), *The Impact of Blockchain Technology on Corporate Governance: Empirical Evidence from U.S. Firms*. Technological innovation has generated a growing number of technologies that have fundamentally transformed financial services and corporate governance structures. Among these innovations, blockchain technology represents a decentralized and transparent system capable of reshaping governance mechanisms. This study investigates the relationship between blockchain technology (BT) and corporate governance (CG) using panel data from 35 U.S. firms over the period 2010–2021. The empirical analysis employs Ordinary Least Squares (OLS) and fixed-effects regression models, with the Hausman test used to determine the most appropriate model. The findings reveal a positive and statistically significant relationship between blockchain adoption and corporate governance. Larger firms are more likely to adopt blockchain technology, thereby enhancing governance quality. Additionally, a significant positive relationship is observed between firm performance and governance. In contrast, leverage, research intensity, and sales volume show no statistically significant effects. These findings contribute both theoretically and empirically by highlighting blockchain as a strategic tool for enhancing transparency,

accountability, and trust in institutional processes. The study also offers practical implications for policymakers and regulators to develop supportive frameworks that encourage blockchain adoption while ensuring data protection. Furthermore, it provides guidance for corporate decision-makers aiming to improve governance efficiency, mitigate agency conflicts, and enhance long-term sustainability in an increasingly digital economy.

Esfahbodi & Sunmola (2026), *Mediating Effects of Blockchain Adoption on Social Sustainability: A Pre- and Post-Adoption Analysis of Socially Sustainable Supply Chains*. Despite the promising potential of blockchain technology to enhance social sustainability in supply chains, its adoption and effective utilization remain underexplored. Grounded in the Dynamic Capabilities View, this study examines the role of social orientation and perceived usefulness as drivers of blockchain adoption and their subsequent impact on future social practices and social performance across pre- and post-adoption stages. Using a quantitative survey of manufacturing organizations in the United Kingdom, the study analyzes the mediating effects of existing social practices in the pre-adoption stage and future practices in the post-adoption stage. The findings indicate that social orientation positively influences blockchain adoption, with this effect being partially mediated by existing social practices. Moreover, blockchain implementation acts as a catalyst for future social practices, which in turn mediate its impact on social performance. This study contributes to operations and supply chain management literature by providing empirical evidence on the mediating role of social practices, highlighting the dynamic interaction between current and future practices, and adopting a multi-stage methodological approach. It also offers managers a strategic tool—Blockchain Technology for Social Sustainability (BTSS)—to maximize the benefits of blockchain in enhancing social sustainability.

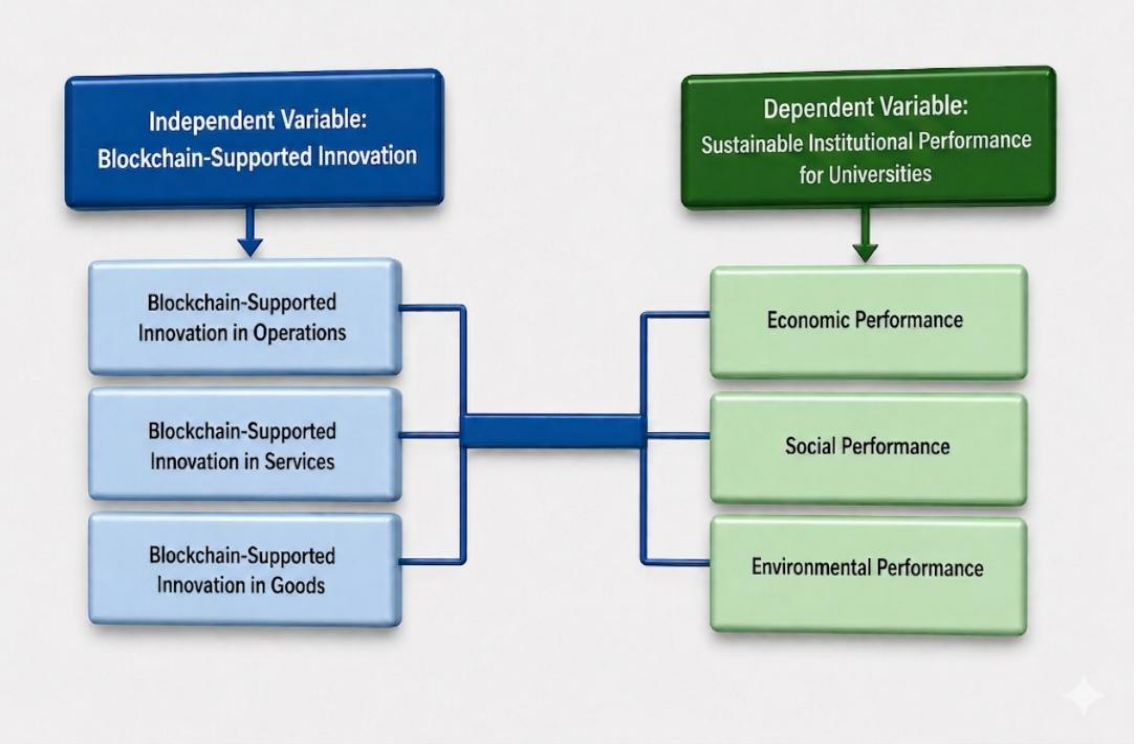
Li et al. (2025), *Unlocking Sustainable Performance with Blockchain Technology: Insights from Organizational Learning Theory* Despite the significant potential of blockchain technology, there remains limited understanding of how it can be effectively integrated into business operations. Drawing on organizational learning theory, this study explores the drivers and outcomes of effective blockchain utilization. Using survey data from 257 Chinese firms, the results show that effective use of blockchain—whether for exploitation or exploration—depends heavily on both external knowledge acquisition and internal knowledge integration. While both modes enhance economic and environmental performance, exploitation has a more substantial overall impact. This is because exploitation typically involves improving existing processes (e.g., enhancing supply chain transparency), leading to immediate performance gains. In contrast, exploration involves experimental and innovative applications (e.g., developing new blockchain-based business models), which require longer timeframes to yield benefits. The study also examines heterogeneity between manufacturing and IT firms. It contributes to the literature by clarifying how firms achieve sustainable outcomes through blockchain and provides managerial insights for adapting strategies in increasingly competitive environments.

Schilhabel et al. (2025), *Blockchain-Driven Business Model Innovation* Blockchain technology is increasingly recognized as a key enabler of business model innovation, offering new opportunities for value creation, delivery, and capture. This study systematically examines blockchain's role through the Antecedents–Decisions–Outcomes (ADO) framework. By integrating insights from a systematic literature review with empirical findings from expert interviews, the study identifies key drivers, barriers, and outcomes of blockchain adoption. It demonstrates how blockchain facilitates decentralization, transparency, and disintermediation, thereby reshaping governance structures and revenue streams while enhancing trust and operational efficiency. The findings enrich business model theory by positioning blockchain within established frameworks such as the Business Model Canvas, Diffusion of Innovations theory, and Transaction Cost Economics. Practical implications include a roadmap for organizations to assess blockchain's strategic fit and recommendations for policymakers to create supportive regulatory environments.

Almadadha (2025), *Blockchain and Financial Performance: Empirical Evidence from Major Australian Banks* This study examines the impact of blockchain adoption on the financial performance of major Australian banks—Commonwealth Bank, Westpac, and ANZ—over the period 2016–2023. Using a descriptive research design and secondary data from annual reports, financial performance is assessed using Return on Assets (ROA) and Return on Equity (ROE). The findings indicate a positive relationship between blockchain adoption and improved financial performance, reflecting gains in efficiency, cost management, and profitability. The study's originality lies in its localized empirical approach, offering context-specific evidence on blockchain's strategic contribution to financial performance within the Australian banking sector.

Alsobhi et al., *Blockchain-Based Micro-Credentialing System in Higher Education Institutions: Systematic Literature Review* Micro-credentials serve as evidence of students' knowledge, skills, and competencies and can contribute toward obtaining larger academic qualifications within a shorter timeframe. This concept has emerged as a rapidly growing trend in higher education, gaining significant momentum, particularly after the COVID-19 pandemic. Higher education institutions face challenges in verifying these credentials, as verification processes are often lengthy, complex, and resource-intensive.

Blockchain technology offers a viable solution by enabling secure and efficient verification of credential data. However, research on blockchain-based micro-credentialing systems remains limited. This study provides a comprehensive overview of the state-of-the-art by identifying system requirements and conducting a systematic literature review (SLR) of studies published between 2016 and 2022. The analysis identifies key research gaps and offers in-depth insights into the development of blockchain-based micro-credential systems in higher education.



Source: Prepared by the researchers

Study Terminology

- **Process Innovation:** Blockchain transforms traditional processes into intelligent, automated systems that ensure transparency and high reliability within academic institutions (Huang & Zhou, 2024; Singh et al., 2023).
- **Service Innovation:** Developing educational services based on tamper-proof digital records, such as micro-credential systems, represents a qualitative leap in enhancing learning experiences (Alsobhi et al., 2023; Haque et al., 2024).
- **Business Model Innovation:** Blockchain enables the restructuring of higher education business models to become more flexible and capable of creating sustainable value beyond centralized systems (Schilhabel et al., 2025; Ali et al., 2023).
- **Economic Performance:** Academic institutions achieve success by improving financial efficiency and returns on technological assets through reduced transaction costs and fraud prevention (Almadadha, 2025; Li, 2025).
- **Social Performance:** Defined by the university's ability to foster fairness, digital accountability, and data privacy for all stakeholders (Sharif & Ghodoosi, 2022; Esfahbodi & Sunmola, 2026).
- **Environmental Performance:** Sustainable universities aim to reduce their carbon footprint by adopting comprehensive digital systems that minimize reliance on physical and paper-based resources (Kouhizadeh et al., 2021; Saberi et al., 2018).

. Blockchain-Enabled Innovation

- **Process Innovation**

Process innovation refers to the introduction of new or significantly improved methods for producing or delivering services, aimed at reducing costs and enhancing operational efficiency within universities. In the context of blockchain, this concept includes the automation of administrative processes through "smart contracts," which

ensure the execution of academic procedures with minimal human intervention (Huang & Zhou, 2024). Empirical evidence suggests that digital process innovation reduces human error and accelerates transaction processing, particularly in paper-based systems (Wang et al., 2019). Moreover, it contributes to establishing a technological "trust system" that minimizes the need for traditional centralized control in managing university records (Singh et al., 2023).

- **Service Innovation**

Service innovation refers to the development of entirely new academic or student services, such as blockchain-based micro-credential systems that provide students with instant and verifiable digital certificates (Alsobhi et al., 2023). This type of innovation goes beyond mere digitization to enhance the end-user experience through transparent and globally accessible services (Haque et al., 2024). One of its most significant features in higher education is the reliable cross-border verification of academic qualifications (Bhatia & Bhasin, 2023). Additionally, such innovations contribute to attracting international students by simplifying admission procedures and facilitating academic recognition.

- **Business Model Innovation**

Business model innovation represents a fundamental transformation in how universities create, deliver, and capture value, leveraging the decentralization offered by blockchain technology. This form of innovation enables the emergence of decentralized universities or collaborative educational platforms that redefine relationships among institutions, students, and the labor market (Schilhabel et al., 2025). Blockchain also supports the development of new financing mechanisms and revenue streams based on digital assets and open research ecosystems (Li et al., 2025). Furthermore, it reduces reliance on traditional administrative intermediaries, thereby fostering more flexible and financially sustainable business models (Ali et al., 2023).

- **Integrated Perspective**

Overall, blockchain-enabled innovation constitutes an integrated system whose dimensions cannot be examined in isolation when assessing its impact on performance. Process innovation provides the foundational infrastructure through smart contracts that ensure efficiency and reliability. Service innovation translates this efficiency into tangible outputs that enhance user experience, such as micro-credential systems. These dimensions are complemented by business model innovation, which reshapes the university's operational philosophy from a centralized entity into a decentralized platform capable of generating sustainable value (Schilhabel et al., 2025; Ali et al., 2023). Thus, the integrative interaction among these three dimensions grants blockchain its innovative character, transforming it from a mere technological upgrade into a strategic driver of radical transformation in higher education (Singh et al., 2023; Li et al., 2025).

Sustainable Institutional Performance in Libyan Universities

- **Economic Performance**

Economic performance refers to the university's ability to efficiently manage its financial resources and generate tangible returns from technological investments while reducing operational costs. Research indicates that blockchain adoption significantly improves Return on Assets (ROA) by lowering transaction costs and preventing financial fraud (Almadadha, 2025). This performance is also linked to the

university's capacity to achieve long-term economic efficiencies through the automation of educational supply chains and procurement processes (Li, 2025). Additionally, financial transparency enabled by digital records enhances the confidence of donors and investors, thereby strengthening institutional financial stability (Ezzine et al., 2026).

- **Social Performance**

Social performance reflects the university's success in meeting stakeholder expectations (students, faculty, and society) while ensuring fairness and transparency in its operations. Blockchain technology plays a critical role in enhancing this dimension by ensuring data privacy and enabling fair, tamper-proof evaluation systems (Sharif & Ghodoosi, 2022). Digital innovation also contributes to increased job satisfaction and institutional loyalty by fostering a work environment characterized by accountability and transparency (Esfahbodi & Sunmola, 2026). Promoting equal access to education and academic resources represents a key social outcome of this performance dimension (Singh et al., 2023).

- **Environmental Performance**

Environmental performance relates to the university's commitment to sustainable practices that reduce its carbon footprint, such as transitioning to a fully paperless university model. Blockchain contributes to this objective by enabling permanent digital records that eliminate the need for extensive physical archives and reduce resource consumption (Kouhizadeh et al., 2021). It also facilitates the tracking of green supply chains within campuses, ensuring that procurement aligns with international environmental standards (Saberi et al., 2018). Furthermore, integrating blockchain with the Internet of Things (IoT) enhances energy and resource management efficiency across university facilities (Haque et al., 2024).

- **Integrated Perspective**

In general, the economic, social, and environmental dimensions collectively form a comprehensive framework for sustainable institutional performance in universities. Improvements in financial efficiency and cost reduction through blockchain generate investment surpluses that enhance social responsibility and digital equity among stakeholders (Almadadha, 2025; Sharif & Ghodoosi, 2022). This interconnection ensures that technological innovation not only delivers economic gains but also contributes to environmental protection through green digital transformation and reduced material waste (Kouhizadeh et al., 2021). Accordingly, sustainable performance represents an interactive system in which financial transparency (economic dimension) strengthens trust and accountability (social dimension), thereby facilitating the adoption of environmentally friendly operational policies (environmental dimension) that ensure long-term sustainability (Esfahbodi & Sunmola, 2026; Ezzine et al., 2026).

METHODS

A . Research Design

This study adopts a quantitative methodology with a deductive approach, deriving hypotheses from the theoretical foundations of Dynamic Capabilities Theory and Service-Dominant Logic. These hypotheses are tested using Structural Equation

Modeling (SEM) to ensure statistical validity and reliability of the findings (Hair et al., 2020).

B . Population and Sample

The study population consists of academic and administrative leaders, faculty members, and IT specialists in Libyan public universities. Due to the difficulty of obtaining a complete population frame, a convenience sampling technique was employed while ensuring adequate representation of major institutions such as the University of Tripoli, the University of Benghazi, and the University of Sabha. Participants were selected based on their familiarity with digital transformation and management information systems to ensure the quality of responses. The study sample consisted of 411 individuals Academic and administrative leaders, faculty members, and IT specialists in Libyan public universities.

C . Data Collection Procedures

Primary data were collected through an electronic questionnaire as the main instrument, given the geographical dispersion of Libyan universities and the ease of reaching respondents by email and professional communication platforms.

D . Measurement Instrument Design

The questionnaire was developed based on previously validated and reliable scales in the literature, adapted to the Libyan university context.

A five-point Likert scale was used to measure all variables, distributed as follows:

- **Blockchain-enabled innovation:** measured using 15 items adapted from (Schilhabel et al., 2025; Wang et al., 2019), covering process, service, and business model innovation.
- **Sustainable institutional performance:** measured using 15 items adapted from (Li et al., 2025; Kouhizadeh et al., 2021), covering economic, social, and environmental dimensions.
-

E . Data Analysis Procedures

The study employed Partial Least Squares Structural Equation Modeling (PLS-SEM).

The analysis followed a two-stage approach:

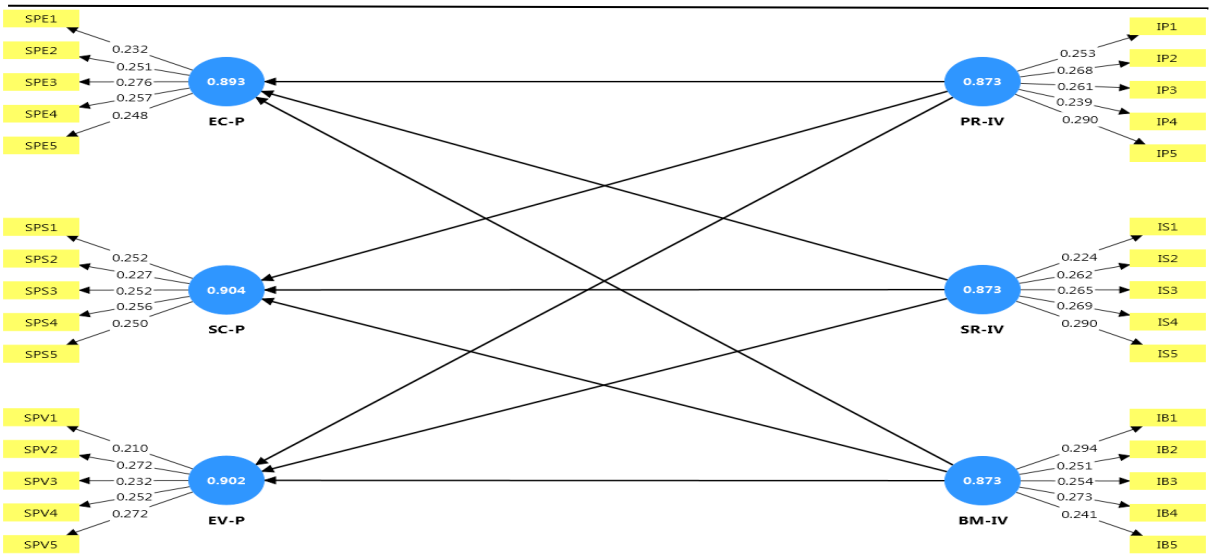
- **Stage 1:** Evaluation of the measurement model, including internal consistency, convergent validity, and discriminant validity.
- **Stage 2:** Evaluation of the structural model, including path coefficients, explanatory power (R^2), effect size (f^2), and predictive relevance (Q^2), as well as relationship analysis.

All analyses were conducted using SmartPLS v4.

Fourth: Data Analysis and Results

4.1. Evaluation of the Measurement Model

Figure (1): Measurement Model Evaluation



Source: *Prepared by the researchers using SmartPLS 4 outputs*

The evaluation of the measurement model for the constructs of sustainable innovation (business model innovation, process innovation, and service innovation) and sustainable performance (economic, social, and environmental performance), as illustrated in Figure (1) and Tables (1) and (2), indicates a high level of measurement quality and robustness. Specifically, all outer loadings exceeded the recommended threshold of 0.70, demonstrating that all indicators adequately represent their respective latent constructs without the need to remove any items. This confirms the high reliability of the indicators (Hair et al., 2021; Hair et al., 2019). Regarding internal consistency reliability, the results show that Cronbach's alpha values ranged between 0.819 and 0.866 for sustainable innovation constructs, and between 0.850 and 0.866 for sustainable performance constructs. Similarly, composite reliability (CR) values ranged from 0.873 to 0.904 across all variables. These values exceed the recommended minimum threshold of 0.70 while remaining below the upper limit of 0.95, indicating strong internal consistency without redundancy or multicollinearity issues among the indicators (Hair et al., 2021; Sarstedt et al., 2014). This confirms that the measurement items consistently reflect the underlying theoretical dimensions of sustainable innovation and sustainable performance. Convergent validity was also established, as evidenced by the Average Variance Extracted (AVE) values, which ranged from 0.58 for innovation-related constructs to between 0.625 and 0.653 for sustainable performance dimensions. All AVE values exceed the minimum threshold of 0.50 (Fornell & Larcker, 1981), indicating that each construct explains more than half of the variance in its indicators.

This confirms adequate convergent validity and the effective application of constructs within the model. Furthermore, discriminant validity was assessed using the Fornell–Larcker criterion. The results show that the square roots of AVE for all constructs (ranging from 0.762 to 0.808) are greater than the inter-construct correlations. This indicates that each construct shares more variance with its own indicators than with other constructs in the model. Additionally, all inter-construct correlations remain below conservative thresholds, supporting the absence of conceptual overlap. Collectively, these results confirm strong discriminant validity and clear conceptual distinction between sustainable innovation and sustainable performance constructs

(Hair et al., 2021; Henseler et al., 2015). Overall, the findings demonstrate that the measurement model possesses strong psychometric properties, including indicator reliability, internal consistency, convergent validity, and discriminant validity. Accordingly, the measurement model is statistically sound and suitable for proceeding to the evaluation of the structural model, enabling robust testing of the hypothesized relationships between sustainable innovation and sustainable performance.

Table (1): Internal Consistency and Convergent Validity

Construct	Item	Outer Loadings	Cronbach's Alpha	Composite Reliability (ρc)	Average Variance Extracted (AVE)
Business Model Innovation	**IB1**	**0.778**	**0.819**	**0.873**	**0.580**
	IB2	0.750			
	IB3	0.748			
	IB4	0.775			
	IB5	0.757			
Innovation in Operations	**IP1**	**0.733**	**0.819**	**0.873**	**0.580**
	IP2	0.797			
	IP3	0.763			
	IP4	0.719			
	IP5	0.793			
Innovation in Services	**IS1**	**0.706**	**0.819**	**0.873**	**0.580**
	IS2	0.770			
	IS3	0.753			
	IS4	0.792			
	IS5	0.783			
Economic Performance	**SPE1**	**0.758**	**0.850**	**0.893**	**0.625**
	SPE2	0.777			
	SPE3	0.829			
	SPE4	0.803			
	SPE5	0.783			
Social Performance	**SPS1**	**0.830**	**0.866**	**0.904**	**0.653**
	SPS2	0.742			
	SPS3	0.809			
	SPS4	0.844			
	SPS5	0.811			
Environmental Performance	**SPV1**	**0.705**	**0.864**	**0.902**	**0.650**
	SPV2	0.831			
	SPV3	0.816			
	SPV4	0.846			
	SPV5	0.824			

Source: *Prepared by the researchers using SmartPLS 4 outputs*

2.4. Structural Model and Hypothesis Testing

The structural model presented in Figure (2) illustrates the direct relationship between blockchain-enabled sustainable innovation and sustainable institutional performance.

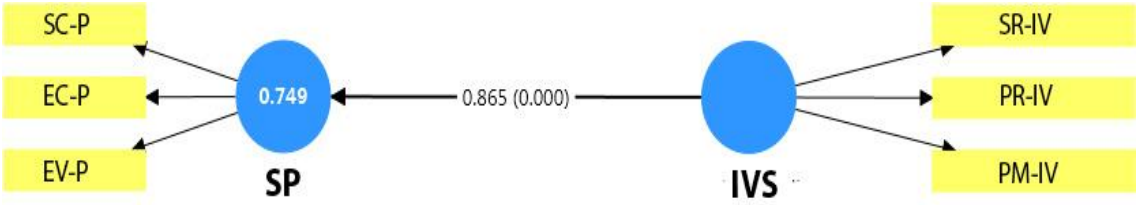


Figure 2. The Structural Model of the Study

- **Hypothesis Testing**

The results of the direct hypothesis test indicate that blockchain-enabled innovation has a strong, positive, and statistically significant effect on sustainable performance ($\beta = 0.865$, $t = 33.055$, $p < 0.001$). This finding highlights the pivotal role of blockchain-driven innovation in enhancing sustainability outcomes at the institutional level. Furthermore, bootstrap results at a 95% confidence level confirm that the confidence interval does not include zero, supporting the robustness and stability of the estimated relationship (Hair et al., 2017). Accordingly, the proposed hypothesis is empirically supported.

Table (2): Structural Model Evaluation and Hypothesis Testing Results

Construct	Original sample (O)	Standard deviation (STDEV)	T statistics (|O/STDEV|)	P values	Confidence intervals %5:%95	Result
Blockchain powered innovation > Sustainable corporate performance	0.865	0.026	33.055	0.000	0.816:0.901	Supported

Note: T-statistics are based on a one-tailed test ($t = 1.645$). Statistical significance at $p < 0.05$.

Source: Prepared by the researchers using SmartPLS 4 outputs

- **Evaluation of Explanatory Power**

Table (3) indicates that the model demonstrates high explanatory power. Specifically, the coefficient of determination for sustainable institutional performance is $R^2 = 0.749$, which is considered substantial (Chin, 1998; Cohen, 1988). This value indicates that approximately 74.9% of the variance in sustainable institutional performance is explained by blockchain-enabled innovation. Moreover, the effect size (f^2) reveals that blockchain-enabled innovation has a very large impact on sustainable institutional performance ($f^2 = 2.983$, $p < 0.001$). The confidence intervals, which do not include zero, further confirm the robustness and stability of this effect. Accordingly, the model can be considered highly effective in capturing and explaining the dynamics of sustainable performance within the context of blockchain-driven digital innovation.

Table (3): Explanatory Power of the Structural Model

Construct	R^2 (Original Sample)	Confidence Interval	f^2 (Original Sample)	Confidence Interval
Sustainable Institutional Performance	0.749	0.665 – 0.813	2.983	1.986 – 4.336

Source: Prepared by the researchers using SmartPLS 4 outputs

- **Evaluation of Predictive Power**

Table (4) presents the predictive power assessment using the Stone–Geisser Q^2 criterion. All Q^2 values are positive, confirming out-of-sample predictive relevance (Hair et al., 2017). Specifically, Q^2 values for sustainable performance dimensions are high:

- Social performance: 0.641
- Economic performance: 0.643
- Environmental performance: 0.553

These values indicate strong predictive capability of the model in explaining endogenous constructs.

To further validate predictive performance, a comparison was conducted between prediction errors of the PLS-SEM model (PLSSEM_RMSE) and a linear model (LM_RMSE), following (Hair et al., 2021; Shmueli et al., 2019).

The results show that RMSE values for PLS-SEM are either lower than or equal to those of the linear model across all dimensions:

- Social performance: 0.602 (PLS-SEM) < 0.606 (LM)
- Environmental performance: 0.671 (PLS-SEM) < 0.677 (LM)
- Economic performance: equal values (0.600)

These findings confirm high predictive accuracy and demonstrate that the model has strong out-of-sample predictive power in explaining sustainable institutional performance.

Table (4): Predictive Power of the Structural Model

Dimension	Q^2predict	PLS-SEM RMSE	LM RMSE
Social Performance	0.641	0.602	0.606
Economic Performance	0.643	0.600	0.600
Environmental Performance	0.553	0.671	0.677

Source: Prepared by the researchers using SmartPLS 4 outputs

RESULT AND DISCUSSION

Interpretation and Discussion

The structural analysis reveals a strong and statistically significant positive effect of blockchain-enabled innovation on sustainable institutional performance in universities ($\beta = 0.865$, $t = 33.055$, $p < 0.001$). This result extends beyond the findings of (Ezzine et al., 2026), which confirmed a positive relationship between blockchain and corporate governance. The current study deepens this understanding by demonstrating that blockchain's impact is not limited to governance mechanisms but constitutes a core driver of comprehensive institutional sustainability in higher education.

The explanatory power of the model ($R^2 = 0.749$) indicates that blockchain innovation accounts for nearly three-quarters of the variance in sustainable performance. This finding supports (Schilhabel et al., 2025), who emphasized blockchain as a key enabler of business model innovation. It suggests that transforming universities into decentralized models contributes significantly to sustainable value creation. The findings also align with (Li et al., 2025), indicating that achieving sustainable performance depends on dynamic capabilities in exploiting and exploring blockchain innovations to enhance processes and services.

Performance Dimensions

- Economic Performance:
- The results are consistent with (Almadadha, 2025), confirming that blockchain improves financial performance by reducing costs and increasing efficiency. This implies that investment in blockchain leads to tangible economic gains through process automation.
- Social Performance: The findings support (Alsobhi et al., 2023), emphasizing the role of blockchain-based micro-credentials in building trust. Digital service innovation significantly enhances stakeholder satisfaction and transparency.
- Environmental Performance: The results align with (Esfahbodi & Sunmola, 2026), confirming blockchain's transformative role in promoting sustainable practices. The model demonstrates that blockchain-driven digital transformation significantly reduces material waste and supports environmental sustainability goals.

Overall, the superior predictive performance of the model, as demonstrated by PLSpredict, provides strong empirical evidence that universities adopting blockchain-based innovation not only improve current performance but also develop predictive capabilities to address future sustainability challenges. This positions blockchain at the core of modern academic strategies.

- Key Findings

1. Measurement Model Quality:

- High reliability: Cronbach's Alpha and Composite Reliability exceeded 0.70.
- Validity: AVE values > 0.50 confirmed convergent validity, while HTMT and Fornell–Larcker confirmed discriminant validity.

- Structural Model Strength:

- Strong direct effect: $\beta = 0.865$, $t = 33.055$.
- High explanatory power: $R^2 = 0.749$ (74.9%).
- Large effect size: $f^2 = 2.983$.

- Predictive Power:

- Q^2 values (0.553–0.643) indicate strong predictive relevance.
- PLS-SEM outperformed or matched the linear model in prediction accuracy.

- Recommendations

Based on the central role of blockchain-enabled innovation in enhancing sustainable performance, the study recommends:

1. Integrating blockchain technology as a core pillar in digital transformation strategies, not merely as a technical tool but as a new business model.
2. Implementing smart contracts for routine operations such as student registration, procurement, and administrative processes to reduce costs and improve efficiency.
3. Adopting blockchain-based micro-credential systems to enhance social performance through secure, verifiable digital certifications.
4. Strengthening digital governance by leveraging blockchain transparency to ensure fairness, accountability, and trust among stakeholders.
5. Transitioning toward green campuses by eliminating paper-based processes and integrating blockchain with IoT for efficient resource management.
6. Investing in human capital by establishing Blockchain Centers of Excellence to bridge the gap between technological innovation and organizational implementation.

CONCLUSION

This study concludes that blockchain-enabled innovation represents a fundamental pillar and a strategic pathway for achieving sustainable institutional performance in Libyan universities. The empirical findings demonstrate a significant positive effect and strong explanatory power of digital innovation in shaping the future of academic sustainability. The integration of innovation dimensions—processes, services, and business models—not only enhances economic and financial efficiency but also redefines social and environmental responsibility through increased transparency and the advancement of green digital transformation. The study further confirms that the success of Libyan universities within the complex and competitive landscape of 2026 depends on their ability to leverage dynamic capabilities to localize blockchain technology and transform it from a mere technical tool into an intelligent business model. Accordingly, this research provides decision-makers in Libyan higher education with a comprehensive applied framework that transcends traditional administrative constraints and establishes a new phase of digital governance and international academic credibility, ensuring resource sustainability and maximizing value for all stakeholders.

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