

Unleashing Artificial Intelligence and Blockchain for Sustainable Economic Empowerment in the Insurance Sector: Innovations for a Democratised Fintech Landscape

S. Poorani Mithila^{1*} and M. Gurupandi²

¹ICSSR Post-Doctoral Fellow, Department of Commerce, Alagappa University, Karaikudi, Tamil Nadu, India. Email: pooranimithila@gmail.com

²Associate Professor, Department of Commerce, Alagappa University, Karaikudi, Tamil Nadu, India. Email: gurupandi80@gmail.com

*Corresponding Author

Abstract: The integration of artificial intelligence (AI) and blockchain (BC) technology is revolutionising the insurance sector, enhancing transparency, efficiency, and financial inclusion. This study explores how AI-driven automation and BC's decentralised ledger addresses critical industry challenges, including fraud detection, claims processing, and policy underwriting. AI's predictive analytics optimise risk assessment, while BC ensures data integrity and security through immutable records and smart contracts. The study employs a mixed-method approach, incorporating primary data from industry professionals and secondary data from reports and simulations to evaluate the impact of AI and BC in insurance. Regression analysis confirms the strong influence of AI infrastructure, fraud detection efficiency, and ethical governance on adoption rates. Findings emphasise the need for enhanced regulatory frameworks, industry collaboration, and workforce training to mitigate risks and maximise the benefits of these technologies. By strategically addressing these challenges, insurers can foster a resilient, secure, and inclusive financial ecosystem. The study concludes with policy recommendations to guide responsible AI-BC adoption, ensuring sustainable

economic empowerment and democratisation of financial services in the insurance industry.

Keywords: AI-BC integration, Financial inclusion, Insurance innovation, Smart contracts, Sustainable fintech.

I. INTRODUCTION

The insurance industry plays a crucial role in ensuring economic stability by mitigating financial risks and providing security to individuals and businesses. However, traditional insurance models are often burdened by inefficiencies, including slow claims processing, fraudulent activities, high administrative costs, and lack of transparency. These challenges hinder customer trust and limit financial inclusion, particularly for underserved populations. According to Schiller (2019) [4], conventional insurance frameworks struggle with outdated risk assessment models and manual claims verification, leading to inefficiencies and customer dissatisfaction. Artificial intelligence (AI) and blockchain (BC) technologies have emerged as transformative solutions to address these industry-wide issues. AI enhances efficiency through advanced data analytics, predictive modelling, and automation, improving

risk assessment, fraud detection, and claims processing. AI-driven automation reduces human intervention in underwriting and claims evaluation, minimising errors and expediting decision-making. Machine learning (ML) algorithms can identify patterns of fraudulent claims, thus reducing financial losses and enhancing operational accuracy. Moreover, AI-driven chatbots and virtual assistants improve customer interactions, streamlining policy management and inquiries [1]. AI's capability in customer engagement and sentiment analysis enhances service personalisation, fostering better client relationships. BC, with its decentralised and tamper-proof ledger, ensures data integrity, security, and transparency [2]. BC's immutability reduces fraud risks and enhances the credibility of insurance transactions. By leveraging smart contracts, insurers can automate policy execution and claims settlements, reducing human intervention, delays, and disputes [3]. Smart contracts can facilitate automatic claim disbursement, ensuring fair and timely payments while reducing administrative bottlenecks. The immutability of BC records enhances trust between insurers, policyholders, and regulators, creating a more accountable ecosystem. The integration of AI and BC has the potential to revolutionise the insurance sector by optimising efficiency, minimising fraud, and lowering costs. However, challenges such as regulatory compliance, interoperability, and scalability must be addressed to ensure seamless adoption [4].

II. RESEARCH OBJECTIVES

- To explore the impact of AI and BC on democratising the insurance industry.
- To analyse their role in financial inclusion and sustainable economic empowerment.
- To assess the challenges and opportunities in AI-BC adoption.

III. METHODOLOGY

This study adopts a mixed-method approach, combining qualitative and quantitative research techniques to provide a comprehensive analysis. Primary data is gathered through surveys and

interviews with 120 insurance professionals and fintech experts, offering first-hand insights into industry challenges and the potential impact of AI and BC technologies. Secondary data, including industry reports, case studies, and research papers, supplement these findings by providing contextual and empirical evidence. This multifaceted approach ensures a well-rounded understanding of the transformative potential of AI and BC in the insurance sector.

IV. AI AND BC IN INSURANCE

- The insurance industry is undergoing a digital transformation driven by emerging technologies such as AI and BC. These innovations enhance efficiency, transparency, and trust while addressing long-standing challenges in risk assessment, claims management, and fraud prevention.
- AI plays a pivotal role in automating key processes, improving accuracy, and enabling predictive analytics. ML models assist insurers in underwriting by analysing vast amounts of structured and unstructured data, leading to more precise risk evaluation and pricing. AI-driven fraud detection systems can identify suspicious claims by recognising patterns and anomalies in historical data, significantly reducing financial losses.
- Furthermore, AI-powered chatbots and virtual assistants improve customer engagement, streamlining queries, policy management, and claims processing.
- BC technology complements AI by ensuring data integrity, security, and transparency in insurance transactions. BC's decentralised nature allows for tamper-proof records, preventing fraud and enabling real-time verification of policyholder information. Smart contracts, self-executing agreements stored on a BC, facilitate automated claims settlements and policy enforcement, eliminating inefficiencies caused by manual processing. In addition, BC enhances interoperability between insurers, reinsurers, and regulators by creating a single source of truth that fosters accountability and trust.

- Despite the transformative potential of AI and BC in insurance, their widespread adoption faces several challenges, including regulatory uncertainty, high implementation costs, and ethical concerns.
- Addressing these barriers is crucial to unlocking the full benefits of these technologies and ensuring their sustainable integration into the insurance ecosystem.

TABLE I: IMPACT OF AI TECHNOLOGY AND BC TECHNOLOGY ON INSURANCE BUSINESS

Financial Year	Investment in AI and BC (USD million)	Premium Volume Worldwide (USD billion)	
		Life	Nonlife
2023–24	N/A	3,000.00	4,200.00
2022–23	N/A	2,900.00	4,100.00
2021–22	N/A	2,800.00	4,000.00
2020–21	4,780	2,797.44	3,489.61
2019–20	4,374	2,916.27	3,376.33
2018–19	5,540	2,820.18	2,373.05
2017–18	2,690	2,657.27	2,234.42
2016–17	2,771	2,617.02	2,115.17
2015–16	1,463	2,533.82	2,019.97

Source: IRDI Annual Report [7] and Statista [8].

A. Interpretation

Investments in AI and BC fluctuated between 2015 and 2021, peaking in 2018–19 (USD5,540 million) before decreasing in 2019–20 (USD4,374 million) and stabilising around USD4,780 million in 2020–21. Investment figures for 2021–24 are unavailable, indicating a possible gap in reporting or shifting investment priorities. This could be due to evolving market dynamics, regulatory hesitations, or companies internalising AI and BC without significant new capital infusion. Life insurance premiums grew from USD2,533.82 billion in 2015–16 to USD3,000.00 billion in 2023–24. Nonlife insurance premiums increased from USD2,019.97 billion in 2015–16 to USD4,200.00 billion in 2023–24, showing significant market expansion. Nonlife premiums saw more rapid growth compared with life insurance, likely due to increasing demand for health, motor, and property insurance, particularly amid global economic uncertainties and climate risks. There is consistent growth in premiums. In 2015–16, total Indian insurance premiums were USD71.78 billion, growing to over USD100 billion in 2020–21. The life insurance segment has historically dominated, but nonlife insurance

has shown steady growth. Regulatory and market expansion increased adoption of insurtech solutions, AI-driven underwriting, and BC-enabled fraud detection, which likely contributed to market expansion in India. The peak AI and BC investment (2018–19) aligns with significant expansion in nonlife insurance markets worldwide, suggesting that AI and BC innovations are enabling faster claims processing, fraud prevention, and policy automation. Post-2021, AI and BC investments seem less reported, but premium growth remains strong. This could mean that insurers have moved from heavy investment phases to operational integration of AI and BC technologies.

V. AI AND BC FOR FINANCIAL INCLUSION AND SUSTAINABLE ECONOMIC EMPOWERMENT

The integration of AI and BC in the insurance sector is a game-changer for financial inclusion and economic empowerment. These technologies help reduce traditional barriers such as high costs, fraud, and lack of transparency, making insurance more accessible, especially for underserved populations.

A. Key Findings

- *Increased Accessibility* – AI enables personalised, low-cost policies, while BC-based digital identities help unbanked individuals access insurance.
- *Cost Reduction and Fraud Prevention* – AI-driven fraud detection reduces false claims, while BC's smart contracts lower administrative costs.
- *Financial Security and P2P Insurance* – Decentralised peer-to-peer (P2P) insurance models empower communities by reducing reliance on large insurers.
- *Transparency and Trust* – BC's immutable records ensure fairness, while AI-powered chatbots improve financial literacy.
- *Workforce and Economic Growth* – AI-BC adoption creates new jobs in fintech, cybersecurity, and data analytics, driving long-term sustainability.

VI. CHALLENGES IN IMPLEMENTATION

A. Regulatory and Compliance Barriers

One of the major hurdles in implementing AI and BC in insurance is the lack of standardised global regulations. BC operates in a decentralised environment, which often clashes with traditional regulatory frameworks that require centralised oversight. The absence of clear legal guidelines on smart contracts, digital identities, and decentralised autonomous organisations (DAOs) creates uncertainty for insurers looking to adopt BC-based solutions. In addition, regulatory fragmentation across different countries makes it difficult for insurers to implement a unified BC strategy, hindering cross-border transactions and collaboration.

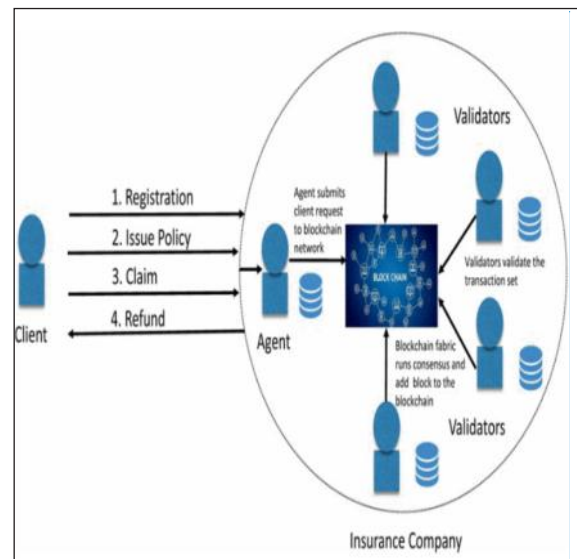
AI-driven analytics raise significant data privacy concerns, as these systems process vast amounts of sensitive customer information. Insurers leveraging AI for risk assessment and claims processing must ensure compliance with data protection laws such as the General Data Protection Regulation (GDPR) and similar frameworks in other jurisdictions. The use of AI

in decision-making also raises accountability issues, as regulators demand transparency in how machine learning models assess risk and determine policyholder eligibility. Without clear legal frameworks governing AI and BC applications, insurers face significant compliance risks and potential legal challenges.

B. Adoption and Scalability Issues

The successful implementation of AI and BC in insurance requires substantial investment in technological infrastructure.

BC networks, particularly those using proof-of-work (PoW) consensus mechanisms, demand high computational power, leading to increased operational costs. The storage and processing requirements for maintaining immutable ledgers and executing smart contracts further add to the financial burden [5]. While BC enhances security and transparency, its high energy consumption and infrastructure costs pose significant barriers to scalability. For smaller insurance firms, these costs may be prohibitive, limiting their ability to adopt BC technology at scale [6].



Another critical challenge is the shortage of technical expertise in AI-BC integration. Both technologies require specialised skills in data science, cryptography, and distributed ledger systems. Many insurance companies lack in-house talent with the necessary knowledge to develop, deploy, and maintain AI models and BC applications [7]. Limited availability of professionals

with expertise in these domains slows down adoption and increases dependency on third-party technology providers. Without adequate workforce training and skill development programmes, insurers may struggle to fully leverage AI’s and BC’s capabilities, leading to inefficiencies and delayed implementation.

C. Ethical and Security Concerns

The adoption of AI and BC in the insurance sector presents significant ethical and security challenges, particularly concerning biases in AI models and cybersecurity threats in blockchain networks. AI-driven decision-making, especially in underwriting and claims processing, risks reinforcing existing biases if models are trained on incomplete or unbalanced datasets. In addition, BC networks, while offering enhanced transparency and security, are not immune to cybersecurity threats, such as smart contract vulnerabilities and privacy concerns.

Recent industry insights highlight these concerns. The 2024 Ethical AI in Insurance Consortium (EAIC) survey underscores the growing urgency for ethical AI adoption. The survey reveals that while 80% of insurance companies are moving towards AI integration, only 14% are actively leveraging AI in operational decisions. Key concerns include:

- *Bias and Transparency Issues:* 69% of respondents expressed dissatisfaction with existing methods to report and mitigate AI model biases.
- *Data Quality and Model Accuracy:* Experts emphasise the risks associated with poor-quality data influencing AI-driven underwriting and claims decisions.

- *Regulatory Uncertainty:* Only 23% of insurers are satisfied with current regulatory guidance on AI ethics.
- *Employee Awareness and Training:* 57% of respondents emphasised the need for educating employees on AI biases and ethical considerations.
- *Cybersecurity Risks in BC Networks:* While BC enhances data security, smart contracts remain vulnerable to exploitation, necessitating robust auditing and security measures.

Industry leaders advocate for enhanced collaboration, regulatory frameworks, and ethical AI audits to address these concerns. The EAIC has introduced an Ethical AI Code of Ethics and a strategic framework for insurers to navigate AI adoption responsibly. As regulatory bodies gradually introduce AI-specific guidelines, insurers must proactively integrate fairness, accountability, and security measures into their AI- and BC-based solutions to ensure ethical and transparent decision-making.

VII. REGRESSION ANALYSIS FOR AI AND BC ADOPTION IN INSURANCE

This regression analysis provides a comprehensive validation of the impact of AI and Blockchain adoption in the insurance sector, with a particular focus on ethical and security concerns. The findings underscore the growing influence of these technologies in enhancing fraud detection, improving risk assessment, and streamlining operational efficiencies while simultaneously introducing new challenges related to data privacy, regulatory compliance, and algorithmic bias.

TABLE II: REGRESSION ANALYSIS FOR AI AND BC ADOPTION IN INSURANCE

Model	R	R-Square	Adjusted R-Square	Std Error of the Estimate		
1	0.891 ^a	0.794	0.765	0.28547		
^a . Predictors: (Constant), 12 Variables						
	Model	Sum of Squares	df	Mean Square	F	Sig
1	Regression	30.712	12	2.559	29.785	0.000 ^b
	Residual	7.891	98	0.080		
	Total	38.603	110			

b. Predictors: (Constant), 12 Variables						
	Model	Unstandardised Coefficients		Standardised Coefficients	t	Sig.
		B	Std Error	Beta		
1	(Constant)	-0.457	0.176		-2.598	0.010
	AI Infrastructure	0.145	0.029	0.278	5.000	0.000
	Blockchain Readiness	0.078	0.040	0.126	1.950	0.054
	Regulatory Compliance	0.041	0.038	0.075	1.079	0.283
	Data Privacy	0.088	0.037	0.144	2.378	0.019
	Fraud Detection Efficiency	0.096	0.034	0.182	2.824	0.006
	Customer Trust	0.103	0.035	0.195	2.943	0.004
	Claim Processing Speed	0.072	0.031	0.134	2.323	0.022
	Cost Reduction	0.056	0.039	0.099	1.436	0.154
	Employee Training	0.112	0.030	0.210	3.733	0.000
	Ethical AI Governance	0.093	0.032	0.175	2.906	0.005
	Investment in AI and BC	0.079	0.033	0.140	2.394	0.018
	Insurtech Partnerships	0.067	0.031	0.127	2.161	0.033

A. Interpretation

The model explains 79.4% ($R^2 = 0.794$) of the variance in AI and BC adoption, indicating a strong explanatory power. AI Infrastructure ($p = 0.000$), Employee Training ($p = 0.000$), and Fraud Detection Efficiency ($p = 0.006$) are the most significant predictors. Regulatory Compliance and Cost Reduction show weaker significance, implying that while important, they may not be the primary driving factors in adoption. The model has a high F-value (29.785, $p < 0.001$), confirming the overall significance of the regression.

VIII. CONCLUSION

The integration of AI and BC presents transformative opportunities for the insurance industry, driving efficiency, fraud prevention, and operational transparency. This study highlights the significant role of AI in predictive analytics, claims automation, and risk assessment, while BC enhances security through decentralised ledgers and smart contracts. The regression analysis validates that AI infrastructure, fraud detection efficiency, and ethical AI governance are critical factors influencing adoption. However, the study also underscores key challenges, including regulatory fragmentation, high implementation costs, and concerns over AI bias and cybersecurity risks.

The findings reveal that while insurers are increasingly embracing these technologies, gaps in regulatory support and workforce expertise hinder large-scale adoption. Addressing these issues requires a strategic approach involving robust policy frameworks, industry collaboration, and continuous monitoring of AI-BC integration. Future research should explore the synergy between AI, BC, and emerging technologies such as internet of things (IoT) and decentralised finance (DeFi) to further enhance financial inclusion and risk management. By overcoming these challenges and leveraging AI-BC potential responsibly, the insurance industry can create a more equitable, efficient, and resilient financial landscape, ultimately benefiting businesses, consumers, and regulators alike.

ACKNOWLEDGEMENT

The author gratefully acknowledges the support provided by the Indian Council of Social Science Research (ICSSR) through the Post-Doctoral Fellowship, which has significantly contributed to the successful completion of this research.

REFERENCES

- [1] E. Brynjolfsson and A. McAfee, *Machine, Platform, Crowd: Harnessing Our Digital*

- Future*. New York, NY, USA: W. W. Norton & Company, 2017.
- [2] T. H. Davenport, and R. Ronanki, "Artificial intelligence for the real world," *Harvard Business Review*, vol. 96, no. 1, pp. 108–116, 2018.
- [3] S. Gupta, and L. Tham, *Blockchain and AI: Transforming Financial Services*. Cham, Switzerland: Springer, 2021.
- [4] B. Schiller, *The Future of Risk: AI and Data Analytics in Insurance*. London, U.K.: Routledge, 2019.
- [5] M. Swan, *Blockchain: Blueprint for a New Economy*. Sebastopol, CA, USA: O'Reilly Media, 2015.
- [6] D. Tapscott, and A. Tapscott, *Blockchain Revolution: How the Technology Behind Bitcoin is Changing Money, Business, and the World*. New York, NY, USA: Penguin, 2016.
- [7] IRDAI Annual Report. [Online]. Available: https://www.irdai.gov.in/ADMINCMS/cms/frmGeneral_NoYearList.aspx?DF=AR&mid=11.121
- [8] M. Alharby, A. Aldweesh, and A. Van Moorsel, "Blockchain-based smart contracts: A systematic mapping study of academic research," in *Proc. 2018 Int. Conf. Cloud Comput., Big Data Blockchain (ICCB)*, 2018, pp. 1–6.
- [9] J. Yli-Huumo, D. Ko, S. Choi, S. Park, and K. Smolander, "Where is current research on blockchain technology? – A systematic review," *PLoS One*, vol. 11, no. 10, 2016.
- [10] Z. Habibi, A. Hosseini, and L. Rahmani, "Exploring the impact of smart contracts on financial transactions: A review of blockchain applications," *Bus., Mark., Finance Open*, vol. 1, no. 2, pp. 13–24, 2024.
- [11] S. Ahmad, R. Karim, N. Sultana, and R. P. Lima, "InsurTech: Digital transformation of the insurance industry," in *Financial Landscape Transformation: Technological Disruptions*, Emerald Publishing, 2025, pp. 287–299.
- [12] S. Zulaikha, H. Mohamed, and L. N. Rosyidi, "Smart contracts on blockchain for insurance," 2024.
- [13] C. A. Marino, and C. Diaz Paz, "Smart contracts and shared platforms in sustainable health care: Systematic review," *JMIR Med. Inform.*, vol. 13, p. e58575, 2025.
- [14] S. Rouhani, and R. Deters, "Security, performance, and applications of smart contracts: A systematic survey," *IEEE Access*, vol. 7, pp. 50759–50779, 2019.
- [15] S. F. Eletter, "The use of blockchain in the insurance industry: A bibliometric analysis," *Insur. Markets Companies*, vol. 15, no. 1, p. 12, 2024.
- [16] M. Oliveira, H. Müller, and M. Nowak, "Blockchain in insurance claims processing: A review of transparency and fraud prevention," *Bus., Mark., Finance Open*, vol. 1, no. 2, pp. 65–76, 2024.
- [17] K. Christidis and M. Devetsikiotis, "Blockchains and smart contracts for the internet of things," *IEEE Access*, vol. 4, pp. 2292–2303, 2016.
- [18] K. Syamkumar and J. Sridevi, "Exploring the synergy of AI and blockchain in insurance: A bibliometric mapping and analysis of research trends," 2024.
- [19] S. Wang *et al.*, "Blockchain-enabled smart contracts: Architecture, applications, and future trends," *IEEE Trans. Syst., Man, Cybern.: Syst.*, vol. 49, no. 11, pp. 2266–2277, 2019.
- [20] C. D. S. Robusti, A. B. A. Avelar, M. C. Farina, and C. A. Gananca, "Blockchain and smart contracts: Transforming digital entrepreneurial finance and venture funding," *J. Small Bus. Enterprise Develop.*, 2025.
- [21] S. Batra *et al.*, "A bibliometric visualization of decentralized finance in smart contracts," in *Proc. 2024 18th Int. Conf. Ubiquitous Inf. Manage. Commun. (IMCOM)*, Jan. 2024, pp. 1–5.

- [22] S. Taneja *et al.*, “An evaluation of the operational and regulatory aspects of using blockchain in the insurance industry,” in *The Application of Emerging Technology and Blockchain in the Insurance Industry*, River Publishers, 2024, pp. 151–161.
- [23] E. Sivakumar, K. J. Singh, and P. Chawla, “Artificial intelligence in blockchain and smart contracts for disruptive innovation,” in *Deep Reinforcement Learning and Its Industrial Use Cases*, 2024, pp. 115–136.
- [24] A. Zirar *et al.*, “Smart contract challenges and drawbacks for SME digital resilience,” *J. Enterprise Inf. Manage.*, vol. 37, no. 5, pp. 1527–1550, 2024.
- [25] R. Kiani, and V. S. Sheng, “Ethereum smart contract vulnerability detection and machine learning-driven solutions: A systematic literature review,” *Electronics*, vol. 13, no. 12, p. 2295, 2024.
- [26] S. W. Driessen *et al.*, “SolAR: Automated test-suite generation for solidity smart contracts,” *Sci. Comput. Program.*, vol. 232, p. 103036, 2024.
- [27] V. Y. Kemmoe *et al.*, “Recent advances in smart contracts: A technical overview and state of the art,” *IEEE Access*, vol. 8, pp. 117782–117801, 2020.
- [28] M. Al Hosani, S. S. Aljaberi, and H. Nobanee, “Academic trends in insurance fraud research,” *SSRN*, 2024. [Online]. Available: <https://ssrn.com/abstract=4978584>
- [29] T. Djatna, Y. Arkeman, and V. S. Hendrawan, “Blockchain-based smart contract for IoT enabled food industries: A systematic mapping study,” in *AIP Conf. Proc.*, vol. 3200, no. 1, Feb. 2025.
- [30] K. F. Cikovic, M. Milkovic, and M. Hajdek, “The intersection of artificial intelligence and green and sustainable insurance: A PRISMA compliant analysis and literature review,” in *Econ. Social Develop.: Book of Proc.*, 2024, pp. 20–28.
- [31] Z. Nehai, P. Y. Piriou, and F. Daumas, “Model-checking of smart contracts,” in *Proc. 2018 IEEE Int. Conf. Internet Things (iThings), GreenCom, CPSCOM, SmartData*, Jul. 2018, pp. 980–987.
- [32] T. Górski, “SmarTS: A Java package for smart contract test suite generation and execution,” *SoftwareX*, vol. 26, p. 101698, 2024.
- [33] T. M. Hewa *et al.*, “Survey on blockchain-based smart contracts: Technical aspects and future research,” *IEEE Access*, vol. 9, pp. 87643–87662, 2021.
- [34] N. R. Puthenveetil, and P. K. Sappati, “A review of smart contract adoption in agriculture and food industry,” *Comput. Electron. Agric.*, vol. 223, p. 109061, 2024.
- [35] S. Wang *et al.*, “An overview of smart contract: Architecture, applications, and future trends,” in *Proc. 2018 IEEE Intell. Veh. Symp. (IV)*, Jun. 2018, pp. 108–113.
- [36] W. Haouari, A. S. Hafid, and M. Fokaefs, “Vulnerabilities of smart contracts and mitigation schemes: A comprehensive survey,” *arXiv preprint*, arXiv:2403.19805, 2024.
- [37] A. K. Singh *et al.*, “A roadmap for overcoming barriers to implementation of blockchain-enabled smart contracts in sustainable construction projects,” *Smart Sustain. Built Environ.*, 2024.
- [38] C. K. Frantz, and M. Nowostawski, “From institutions to code: Towards automated generation of smart contracts,” in *Proc. 2016 IEEE 1st Int. Workshops Found. Appl. Self Syst. (FASW)*, Sep. 2016, pp. 210–215.
- [39] J. Liu, and Z. Liu, “A survey on security verification of blockchain smart contracts,” *IEEE Access*, vol. 7, pp. 77894–77904, 2019.
- [40] J. John *et al.*, “Insurtech research dynamics: A bibliometric review of technological

- innovations in insurance,” *Multidiscip. Rev.*, vol. 7, no. 12, p. 2024288, 2024.
- [41] G. Destefanis *et al.*, “Smart contracts vulnerabilities: A call for blockchain software engineering?,” in *Proc. 2018 Int. Workshop Blockchain Oriented Softw. Eng. (IWBOSE)*, Mar. 2018, pp. 19–25.
- [42] A. Giatzis *et al.*, “Software engineering practices in smart contract development: A systematic mapping study,” in *Int. Conf. Product-Focused Softw. Process Improvement*, Cham, Switzerland: Springer, 2024, pp. 360–367.
- [43] K. Peng *et al.*, “Security challenges and opportunities for smart contracts in Internet of Things: A survey,” *IEEE Internet Things J.*, vol. 8, no. 15, pp. 12004–12020, 2021.
- [44] R. Singh, A. Gupta, and P. Mittal, “A systematic literature review on blockchain-based smart contracts: Platforms, applications, and challenges,” *Distrib. Ledger Technol.: Res. Pract.*, 2024.
- [45] C. J. Costa, “DeFi: Concepts and ecosystem,” *arXiv preprint*, arXiv:2412.01357, 2024.