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Economic Impact of Cryptocurrency Technologies in the Era of 4IR and 5IR: A Systematic Literature Review

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Abstract:

The rapid development of cryptocurrency technologies now strongly affects worldwide economic change as nations implement the Fourth and Fifth Industrial Revolutions (4IR and 5IR). This review system investigates how blockchain technology and DeFi and smart contracts and digital identity systems interact with new governance approaches including regulatory sandboxes and innovation hubs. The 4IR focuses on digital automation and technological convergence yet the 5IR brings forward an ethical human-centered approach to innovation. The current governance systems face challenges because they operate independently from each other in different geopolitical areas while researchers study cryptocurrency regulation through different conceptual frameworks. The study uses PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines for its Systematic Literature Review (SLR) to combine peer-reviewed articles from 2020 onwards for addressing these research gaps. The review examines 73 scholarly articles which were chosen through a multi-stage screening method in leading academic databases. The research uses thematic coding and semantic analysis to detect worldwide governance patterns and experimental regulatory approaches and ethical innovation indicators in 4IR and 5IR environments. The research investigates how cryptocurrency technologies transform economic systems into more inclusive systems which maintain adaptability and ethical principles. The research develops expandable governance systems which enable enduring digital transformation across multiple international environments.

Keywords:

Cryptocurrency, Fourth Industrial Revolutions (4IR), Fifth Industrial Revolutions (5IR), Innovation Hub, Regulatory Sandboxes

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Introduction

The fast adoption of cryptocurrency systems into worldwide financial networks has not solved economic challenges arising from their integration with Fourth and Fifth Industrial Revolution frameworks. The 4IR emphasizes digital automation and technological convergence, while the 5IR introduces ethical human-centered innovation. Governance of cryptocurrency operates through separate systems lacking coordination between political territories. Researchers have studied blockchain interactions with artificial intelligence in changing industrial environments, including cryptocurrency operations and medical technology development (Gwala, 2025). Studies by Kumar et al. (2022), Malviya et al. (2023), Verma et al. (2024), and Ramachandran et al. (2023) examined AI-based blockchain applications in public health, healthcare management, and cybersecurity for 5IR.

The scalability and long-term effects of regulatory sandboxes and innovation hubs on ethical and inclusive systems remain unclear. Academic study of cryptocurrency governance faces obstacles due to lack of standard definitions and unified governance systems. Research seeks to create enduring oversight supporting transformative objectives of 4IR and 5IR. Cryptocurrency technology has transformed the world economy, challenging established financial systems and governance frameworks (Makarov & Schoar, 2022; Wronka, 2023). Mpofu and Mpofu (2024) and Challoumis & Eriotis (2024) highlight blockchain, DeFi, smart contracts, and digital identity systems as essential for innovation and inclusion.

4IR is defined as the convergence of advanced technologies that automate, digitize, and transform industries and societies at an unprecedented pace (Hossain, 2023; Johnson, 2020; Muralidhar & Lakkanna, 2024; Singh, 2024; Wagh & Tripathy, 2024; Rohilla, Jindal & Jindal, 2025). Whereas 5IR is defined as the representation of technological era where human values and ethics are embedded into innovation, ensuring that digital transformation supports both economic progress and social justice (Saha, 2025; George & George, 2024; Oyedokun, 2025; Tang et al., 2020; Shin & Rice, 2022; Bappy Cheon & Islam, 2025). Cryptocurrency is defined as a decentralized, cryptographically secured digital currency recorded on blockchain networks, enabling direct transactions without traditional financial intermediaries (Ozili, 2023; Pantin, 2023; Di Prisco & Strangio, 2025; Omarova, 2020; Jameaba & Ssenyonga Jameaba, 2022; Vasishta, Dhiman, Smith & Singla, 2025; Ferreira & Sandner, 2021; Durham, 2023).

4IR integrates artificial intelligence, big data, robotics, and IoT to create automated digital systems (Hossain, 2023). Cryptocurrency technologies act as disruptive elements enabling peer-to-peer systems, programmable trust, and decentralized governance (Johnson, 2020; Muralidhar & Lakkanna, 2024; Singh, 2024; Wagh & Tripathy, 2024; Rohilla, Jindal & Jindal, 2025). The 5IR emphasizes ethical innovation, sustainability, and human-centered design (Saha, 2025). New technological eras demand

systems combining operational excellence with social fairness and human welfare (George & George, 2024). Financial service democratization aligns with human-centered goals, but governance and ethical compliance issues remain unresolved (Bappy Cheon & Islam, 2025).

Ayodeji et al. (2023); Khan (2023); Nwafor (2024); Oluwaferanmi (2025a) note challenges due to uncoordinated regulatory environments. Geopolitical areas implement governance systems with poor alignment and weak moral foundations (Kavaloski, 2024; Koriahina, 2024). Innovation hubs and regulatory sandboxes act as experimental testing grounds for new applications (Durham, 2023; Goyal & Yadav, 2024). These frameworks promise inclusive practices but need further investigation for adaptability (Butt, 2023; Roy, Dubey & Tiwary, 2024; Safarli & Safarli, 2024; Lose & Kalitanyi, 2025). The literature emphasizes that fragmented governance remains a barrier to cryptocurrency's transformative potential.

The existing academic research on cryptocurrency governance faces challenges because different disciplines study it independently, creating inconsistent conceptual frameworks. Oleet (2025) and Oluwaferanmi (2025a) argue that this fragmentation hinders the creation of complete governance systems which would direct cryptocurrency technology implementation into economic systems undergoing 4IR and 5IR transformations.

This study aim to conducts a SLR to analyse the economic impact of cryptocurrency systems under the combined influence of 4IR and 5IR frameworks. It combines peer-reviewed articles from 2020 onwards to discover worldwide governance systems, experimental regulatory methods, and ethical development markers. To address the study objective, this study respond to the following research questions: *(1) What are the economic impacts of cryptocurrency systems within 4IR and 5IR frameworks? (2) How do governance mechanisms such as regulatory sandboxes and innovation hubs influence adoption and regulation? (3) What ethical and human-centered challenges emerge in cryptocurrency governance? (4) How do regional differences shape adoption and governance outcomes?*

Methods and Data

The research investigates cryptocurrency technology economic impact through a SLR that examines these impacts within the 4IR and 5IR. The research design provides transparent methods for selecting and analyzing scholarly content to achieve both reproducibility and research quality. The research follows PRISMA guidelines to establish a systematic review framework which maintains methodological integrity. "The researchers also developed exclusion criteria to remove specific papers from the review (Connelly, 2020; Mashau, Nenzhelele & Ramasimu, 2024)"

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Research Design

The research uses qualitative exploratory methods based on systematic review principles to achieve its objectives. The research combines academic studies about cryptocurrency technologies including blockchain and DeFi and smart contracts and digital identity systems and their governance systems which include regulatory sandboxes and innovation hubs. The research investigates thematic and semantic patterns which demonstrate how these technologies drive economic changes during the 4IR and 5IR. The research design addresses the current fragmented academic literature because it studies various disciplines and international settings. The research combines various academic sources to create a unified understanding of cryptocurrency governance systems that support ethical and inclusive and flexible innovation approaches.

Search Strategy

The research used a complete search method to find relevant publications from 2020 to 2025. The research databases include Scopus and Web of Science and SpringerLink and IEEE Xplore and JSTOR and ProQuest and EBSCO and Google Scholar. The search used Boolean operators to combine specific keywords which produced the following search terms: "Cryptocurrency" AND ""Fourth Industrial Revolution" AND Fifth Industrial Revolution. The research focused on scholarly articles from peer-reviewed journals and conference papers that used English as their language of publication. The research included studies that demonstrated direct connections between cryptocurrency technologies and governance systems and their social and economic effects on 4IR and 5IR.

Study Selection, Inclusion and Exclusion Criteria

The literature selection process consisted of multiple stages to evaluate potential studies. The first stage of screening involved examining titles and abstracts to eliminate non-academic content and irrelevant studies. The full-text evaluation process checked both the study's compliance with research criteria and its connection to the investigation's main question. The researchers chose about 73 relevant sources for detailed thematic and semantic evaluation after final selection.

The research includes studies which examine cryptocurrency technologies within the context of 4IR/5IR and their governance systems and economic transformation processes. The research focuses on governance systems that include regulatory sandboxes and innovation hubs as well as their analytical aspects. The study includes research papers and theoretical models and policy documents that focus on global or international subjects. The research excluded all non-academic content and media reports that lack proper academic standards and all studies that fail to demonstrate analytical value or economic transformation potential.

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Inclusion Criteria	Exclusion Criteria
• Studies that explores governance innovations such as regulatory sandboxes, innovation hubs, or experimental policy frameworks • Studies that explicitly engage with 4IR and/or 5IR contexts • Studies that apply or discuss conceptual frameworks for cryptocurrency regulation or digital governance	• All research articles published before 1 January 2020 or after 31 August 2025 • Research articles duplicated • Research articles not written in English. • Articles that were not peer-reviewed • Articles not related to the cryptocurrency concept

Table 1: Inclusion and exclusion criteria

Following the removal of 483 duplicated articles from the original 1270 records, the researchers evaluated the remaining 787 articles for relevance by reviewing the titles, keywords, and abstracts. 714 of these papers were excluded not relevant to “cryptocurrency”, “Fouth industrial revolution” and “Fouth industrial revolution”. 73 articles were chosen for a final review pool based on their relevance to the study question. Below is figure 1 outlining the analysis of the study.

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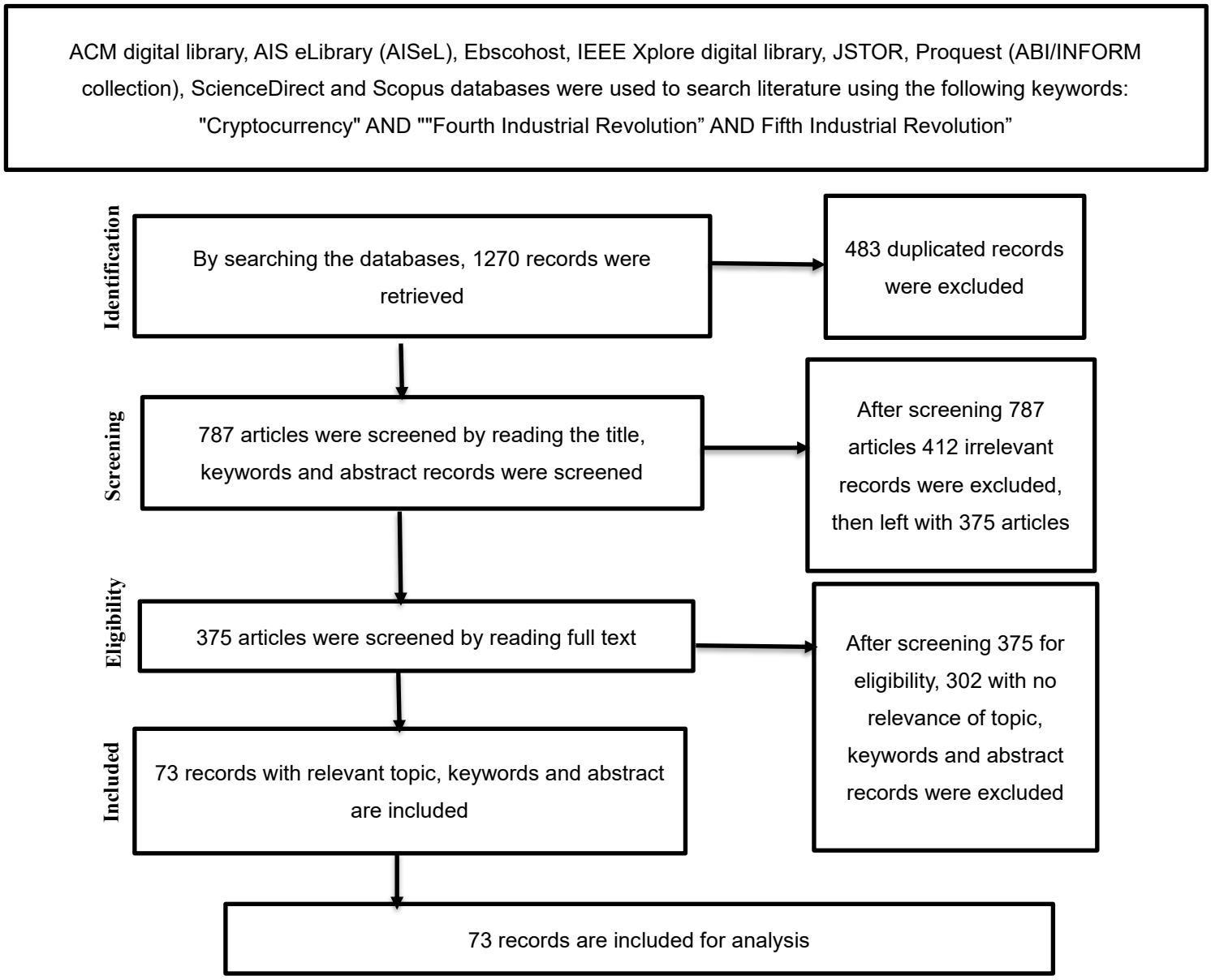

Figure 1: Literature identification diagram

Results and Discussion

As stated in the methodology Section, this study conducted a systematic literature review to acquire additional insight into the topic around "Cryptocurrency" AND ""Fourth Industrial Revolution" AND Fifth Industrial Revolution. In this section, the authors present the elements of collected articles to provide detailed cryptocurrency adoption impact on economies literature in relation to governance practices. This was achieved by analysing the literature in the review of the final 73 articles. In the study, the authors discovered that the number of Cryptocurrency" AND ""Fourth Industrial Revolution" AND Fifth

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Industrial Revolution" related published publications increased in 2020 (n = 5), decreased in 2021 (n = 4), and increased in 2022 (n = 7) (Figure 2). with the continued increase in articles in 2023 (n = 14), 2024 (n = 25) and 2025 (n = 18). The findings confirm that Cryptocurrency within 4IR and 5IR is increasing over the years. The study by Guo, Yousef and Naseer (2025) analysed 37 countries through panel data to show that adoption rates depend heavily on technological readiness and monetary policy systems and inflation levels. Cryptocurrencies function as protection against currency devaluation in countries with high inflation rates because they provide an alternative value storage option (Belke & Beretta, 2020; Luchkin et al., 2020; Agarwal et al., 2021; Marthinsen & Gordon, 2022; Mirkamol & Mansur, 2023; Amatus, 2024). Furthermore, Luo (2025) indicates that the research in adoption impact of cryptocurrencies by financial institutions established an inverse relationship between cryptocurrency adoption and GDP growth which indicates that fast technological progress creates challenges for institutional stability.

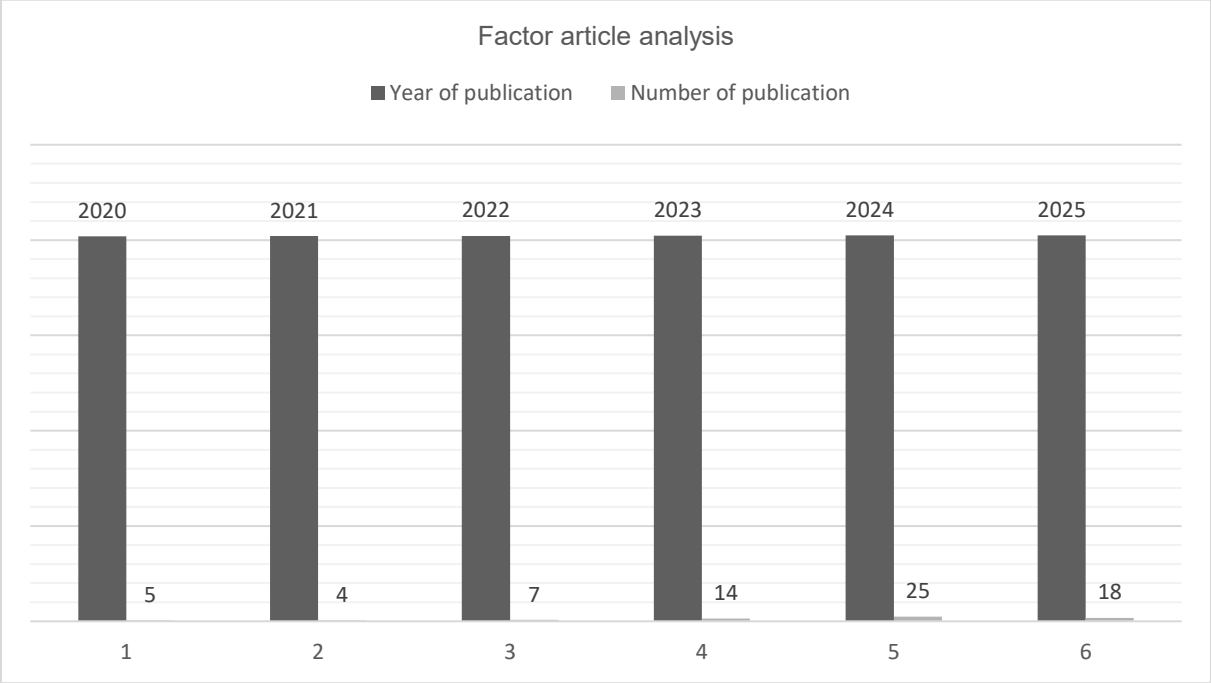

Figure 2: Factor Article Analysis

Cryptocurrencies function as financial inclusion tools for people lacking access to conventional banking services (Ozili, 2023; Pantin, 2023; Di Prisco & Strangio, 2025), and DeFi platforms provide loans, savings, and investment services without traditional institutions (Omarova, 2020; Jameaba & Ssenyonga Jameaba, 2022; Vasishta, Dhiman, Smith & Singla, 2025). Insufficient regulatory oversight exposes users to security threats (Agoraki, Kouretas & Triantopoulos, 2020; Wronka, 2023), while fraud, market manipulation, and asset loss erode trust (Fisher, 2023; Akbar, Hussain, Usman & Afzal, 2025;

Taavitsainen, 2025). Adoption must balance economic advantages with risks to financial institutions (Sestino, Tuček & Bresciani, 2025), as rapid growth fosters volatility and speculation (Asif & Unar, 2024). Flexible governance systems are needed to protect innovation while managing dangers (Scherer & Voegtlin, 2020), supported by models combining real-time tracking and multi-industry partnerships (Otunba, Adenuga, Sikiru & Gaffar, 2024). Cryptocurrency systems operate within an evolving environment uniting 4IR and 5IR, with Blockchain and DeFi platforms acting as incubators for technological advancement and policy development (Shin & Rice, 2022). Innovation hubs incorporating ethical design and human-centered values fulfill 5IR objectives (Oyedokun, 2025), requiring continuous funding and inclusive decision-making (Pantin, 2023). These hubs are essential for embedding ethics into governance frameworks, though restricted research focus prevents full understanding of the relationship between cryptocurrency systems and 4IR/5IR (Oluwaferanmi, 2025a). Interdisciplinary collaboration and ethical operationalization are emphasized in governance models (Tang et al., 2020; Cunha et al., 2021; Shin & Rice, 2022; Chohan, 2023; Alibašić, 2025; Saiedi et al., 2021; Radanliev, 2024).

Governance depends heavily on regulatory sandboxes and innovation hubs (Ferreira & Sandner, 2021; Durham, 2023), with governance remaining a primary obstacle in adoption (Ayodeji et al., 2023; Wronka, 2024; Sestino et al., 2025). Current systems lack proper tools to manage decentralized technologies (Bassey, Rajput & Oyewale, 2024; Uzougbo, Ikegwu & Adewusi, 2024), though controlled testing environments allow collaboration between regulators, technologists, and stakeholders (Ayodeji, Oyeyipo, Attipoe, Isibor & Mayienga, 2023; Lose & Kalitanyi, 2025; Oluwaferanmi, 2025a). Sandboxes work best in developing markets with limited institutional capabilities (Goyal & Yadav, 2024), and iterative policy development makes them suitable for environments changing under 4IR and 5IR transitions (Oluwaferanmi, 2025b). These frameworks foster collaboration but face scalability and transferability challenges (Truby, Dahdal & Ibrahim, 2022), while innovation hubs provide infrastructure, funding, and mentorship to support startups and research (Peerzada & Verma, 2025; Chohan, 2023).

The economic effects of adoption differ across regions (Saiedi, Broström & Ruiz, 2021), with digital assets serving remittances in developing countries (Putrevu & Mertzanis, 2024) and investment or speculation in developed economies (Hrytsai, 2022). Effective policies require awareness of economic settings (Saiedi et al., 2021; Shahzad, Xu, Lim, Hasnain & Nusrat, 2024), and Guo et al. (2025) stresses the need to understand long-term impacts. Adoption patterns are shaped by inflation, institutional trust, and regulatory clarity, while cultural background and legal frameworks influence ethical principles (Tang et al., 2020; Sestino et al., 2025). Rates vary depending on digital maturity and readiness (Tutak & Brodny, 2022; Oloyede, Faruk, Noma, Tebepah & Nwaulune, 2023), with countries like Singapore and Switzerland having established systems while others struggle with enforcement (Lindsay, 2022). Strong institutions foster organized governance (Ayodeji et al., 2023; Butt, 2023; Nwafor, 2024), the EU's MiCA

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regulation minimizes fragmentation (Van Der Linden & Shirazi, 2023; Frunzeti & Dumitru, 2024; Wronka, 2024), and international organizations such as the IMF, World Bank, and FATF provide guidelines and support (Whitford & Anderson, 2021; Butt, 2023; Kavaloski, 2024; Al-Tawil, 2023; Anggriawan & Susila, 2024).

Region/Country	Governance Approach	Adoption Rate	Key Drivers & Barriers
United States	Mixed federal and state-level regulation; SEC oversight; innovation hubs in California	11.3%	Strong tech infrastructure; regulatory uncertainty; SEC enforcement actions
European Union	Unified MiCA framework; sandbox pilots in France, Germany, Netherlands	9.2% (varies by country)	Regulatory clarity; GDPR compliance; cautious institutional adoption
Nigeria	Central Bank restrictions; active sandbox programs; high DeFi usage	17.8%	Hedging inflation; financial exclusion; mobile-first economy
Argentina	Informal adoption; limited governance; crypto as inflation hedge	18.5%	Currency instability; lack of formal regulation; grassroots adoption
Turkey	Centralized oversight; crypto taxed; sandbox initiatives underway	16.1%	Inflation-driven demand; evolving policy stance
India	Regulatory ambiguity; RBI cautious; innovation hubs emerging	9.4%	Large youth population; fintech growth; unclear legal status
South Africa	Intergovernmental Fintech Working Group; sandbox trials; draft crypto regulations	10.2%	Institutional engagement; financial inclusion goals; regulatory delays
Brazil	Central Bank-led governance; sandbox and pilot programs active	12.7%	Strong fintech sector; initiative-taking regulation; regional disparities
Singapore	MAS-led sandbox; clear licensing regime; global crypto hub	13.9%	Regulatory clarity; institutional adoption; innovation-friendly environment
China	Crypto ban; focus on CBDC (e-CNY); strict governance	<1% (formal crypto use)	State control; surveillance concerns; blockchain innovation without crypto
Russia	Ambiguous stance; limited governance; crypto used for cross-border transactions	7.6%	Sanctions circumvention; lack of institutional support
United Arab Emirates	Pro-crypto zones such as Dubai; sandbox and licensing frameworks	14.5%	Strategic positioning; global investment; regulatory agility
Canada	Provincial sandboxes; federal oversight; active innovation hubs	10.8%	Institutional trust; balanced regulation; strong consumer protection
Australia	ASIC-led governance; sandbox programs; clear tax treatment	11.9%	Regulatory transparency; fintech integration; consumer education

Table 2: Geographic Analysis of Cryptocurrency Governance and Adoption
(Source: Authors own construction)

Discussion

The literature shows that cryptocurrency systems operate within an evolving system uniting 4IR and 5IR, while governance encounters obstacles due to economic and digital sovereignty benefits and

ethical innovation possibilities. Research must continue to assess the potential of regulatory sandboxes and innovation hubs for scalability and contextual effectiveness (Truby et al., 2022). Academic research requires a complete assessment of knowledge gaps because it lacks standardized conceptual models and ethical frameworks (Tang et al., 2020; Shin & Rice, 2022). The absence of standardized frameworks demands a comprehensive review to combine existing knowledge and create new directions. These challenges highlight the need for interdisciplinary collaboration to address governance complexities.

The systematic review demonstrates blockchain technology and cryptocurrency systems as building blocks for 4IR, with decentralized structures enabling secure and transparent operations. Smart contracts and DeFi platforms became leading elements by automating financial operations and reducing reliance on conventional banking systems (Oleet, 2025). The literature about 5IR presented cryptocurrency technologies as tools serving human needs while respecting ethical standards. Ethical issues such as data privacy, algorithmic bias, and surveillance threats were widely noted. Researchers acknowledged 5IR principles but failed to create specific methods for integrating ethical design into governance systems.

Studies examining both revolutions developed governance systems uniting technological advancement with social accountability, using sandboxes and innovation hubs to support stakeholder participation (Ranchordas & Vinci, 2024). The literature demonstrates that cryptocurrency technologies must align with 4IR and 5IR principles for lasting transformation. Semantic analysis exposed multiple disciplinary terms with different meanings, creating fragmentation in definitions of decentralization, digital sovereignty, and financial inclusion. These inconsistencies hinder interdisciplinary teamwork and policy coordination. Standardized definitions and conceptual frameworks are needed to achieve inclusivity and coherent development.

The review demonstrated that cryptocurrency adoption produces different economic effects across regions, with inflation-prone economies using digital assets to protect wealth (Ba & Şen, 2024). High adoption rates in these areas produced negative GDP effects (Guo et al., 2025), while rapid technological adoption disrupted established frameworks (Lescrauwaet, Wagner, Yoon & Shukla, 2022). DeFi platforms improved access to banking in areas with minimal infrastructure (Bakare, Omojola & Iwuh, 2024). The lack of regulatory oversight created risks of fraud, manipulation, and asset theft (Wronka, 2023; Wronka, 2024). Effective governance systems must protect consumers while fostering innovation.

Conclusion

This exploratory study systematically reviewed 73 scholarly sources to investigate the economic impact of cryptocurrency technologies within the frameworks of the 4IR and 5IR. The literature review revealed

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a fragmented yet rapidly evolving academic landscape, where blockchain, DeFi, smart contracts, and digital identity systems are reshaping financial ecosystems. Governance mechanisms such as regulatory sandboxes and innovation hubs emerged as central tools for managing this transformation.

Using PRISMA-guided systematic literature review (SLR), the study employed thematic coding and semantic analysis to uncover global governance patterns and ethical innovation indicators. The results demonstrated that cryptocurrency technologies are foundational to 4IR goals such as automation, decentralization, and interoperability while also aligning with 5IR's ethical imperatives, including inclusivity, human-centric design, and social accountability.

The discussion highlighted regional disparities in cryptocurrency adoption, with developing economies leveraging digital assets for financial inclusion and remittances, while developed economies focus on investment and speculation. However, ethical challenges such as data privacy, algorithmic bias, and surveillance risks remain unresolved. Semantic fragmentation across disciplines and geographies further complicates policy coordination and interdisciplinary collaboration.

Contribution of the Study

The research adds value to digital transformation studies through its methodical review of cryptocurrency technology impact on worldwide economic systems during the 4IR and 5IR. The research unites different regulatory systems from various digital areas and theoretical models to create a governance system which enables continuous digital transformation. The research develops new theoretical knowledge and policy applications through its method of uniting technological unification with human-focused development to guide upcoming cryptocurrency research and regulatory framework development.

Implications of the Study

Policy Development - The study underscores the urgent need for standardized terminology and conceptual frameworks to support coherent and inclusive cryptocurrency governance. Ethical *Integration* -There is a critical gap in embedding 5IR ethical principles into digital financial systems. Without clear ethical design strategies, governance models risk perpetuating systemic inequalities. *Flexible Regulation* - Adaptive governance systems such as regulatory sandboxes and innovation hubs are essential for managing diverse economic contexts and technological adoption rates.

Limitation of the Study

The study faces a major restriction because it depends on peer-reviewed articles from January 2020 to September 2025 which might omit essential knowledge from previous research and current grey literature about cryptocurrency governance. The study uses thematic coding and semantic analysis to

detect patterns, but these methods might miss important contextual elements which affect policy development in specific geopolitical areas. The different conceptual frameworks employed in the selected articles create difficulties for researchers to combine their findings which reduces the study's ability to produce generalizable results. The review's global representativeness suffers from the exclusion of non-English publications because cryptocurrency innovation and governance experimentation occur at a fast pace in regions beyond the Anglophone academic world.

Recommendations for Future Research

Operationalizing Ethics in Governance - Future studies should develop actionable models for integrating ethical principles into cryptocurrency systems, particularly in areas like data protection and algorithmic fairness. *Cross-Disciplinary Frameworks* - Research should aim to harmonize semantic definitions across disciplines to reduce fragmentation and improve policy interoperability. *Impact Assessment Models* - There is a need for longitudinal studies that assess the macroeconomic effects of cryptocurrency adoption, especially in inflation-prone and low-infrastructure regions. *Stakeholder-Centric Innovation* - Future research should explore participatory governance models that include regulators, technologists, and end-users in policy design and testing environments. *Comparative Regional Studies* - Investigating how different geopolitical regions implement cryptocurrency governance can reveal best practices and context-specific challenges.

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