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Enhancing social protection through blockchain-based identity verification and data communication: A systematic review

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Abstract. This study reviews blockchain's potential to enhance social protection programmes through identity verification and data communication. Traditional systems face issues like unreliable identity verification and data vulnerability, which blockchain's decentralized, immutable, and transparent nature can address. The study aims to analyse blockchain's benefits, current implementations, and deployment challenges in social protection. Using a systematic literature review, 101 articles from 2020-2023 were analysed. The results show blockchain enhances security, transparency, and efficiency in social protection, with successful cases in cash transfers and digital identities. However, challenges include scalability, security, and regulatory issues. Future research should focus on lightweight blockchain models, privacy protections, and the socio-political context of implementations. The study concludes that blockchain can make social protection systems more secure, efficient, and inclusive, but overcoming technical and regulatory hurdles is essential.

Keywords: blockchain, data communication, identity verification, poverty reduction, social protection

1. Introduction

Traditional social protection systems face challenges in reliable identity verification, secure exchange of beneficiary data, and vulnerability to fraud. These shortcomings can lead to the misallocation of resources, exclusion of eligible persons, and erosion of trust in these social welfare programmes.

Data communication and networks underpin the rapid exchange of information that defines our modern world. From financial transactions to social media interactions, the secure and efficient flow of data is fundamental to a wide range of societal functions [1]. However, conventional data communication models often rely on centralized intermediaries, rendering them vulnerable to security threats, single points of failure, and a lack of transparency [2]. Blockchain technology has emerged as a potentially revolutionary force in addressing these challenges by offering a decentralized, immutable, and transparent way to manage and communicate data [3].

Blockchain-based identity verification represents a compelling application within this space. By replacing traditional identity verification systems with blockchain's cryptographic security and distributed structure, it promises greater accuracy, user control over personal data, and resistance to fraudulent manipulation [4]. Moreover, blockchain-based data communication has the potential to streamline information sharing, enhance collaboration, and protect the integrity of data throughout its lifecycle, offering benefits for various sectors [5].

Within this context, social protection programmes stand to gain significantly from the integration of blockchain-based identity verification and data communication. Social protection initiatives, such as cash transfers, food assistance, and healthcare subsidies, typically serve vulnerable populations. Ensuring accurate targeting, secure disbursement of benefits, and the mitigation of fraud are essential to safeguarding the welfare of intended recipients [6]. This technology has the capacity to address these challenges by providing tamper-resistant identification, enabling verifiable data tracking, and fostering transparency in social protection processes.

1.1 Study Objectives

The study explores the benefits of blockchain technology integration, analyses existing implementations, and discusses the challenges and considerations involved with successful deployment. The main objectives of the study are:

(i) Analyse the potential benefits of blockchain-based identity verification and data communication technologies for social protection programmes.
(ii) Examine existing implementations of blockchain in social protection initiatives.
(iii) Identify challenges and considerations for the successful deployment of blockchain in social protection systems.

2. Methodology

A systematic literature review method is used to locate pertinent studies on blockchain-based identity verification and data communication within social protection programmes. The protocol [see Data Availability] was developed following the PRISMA 2020 statement.

2.1 Search Strategy

Searches are conducted in multiple academic databases relevant to computer science, social policy, and development studies:

- Google Scholar: - Though technically not an academic database in the traditional sense, Google Scholar is used to capture a broader range of materials since it casts a wide net across various disciplines and sources.
- Scopus
- ScienceDirect
- IEEE Xplore

Keywords related to blockchain, identity verification, data communication, and social protection are combined using Boolean operators (AND, OR) to refine the search and obtain relevant results. Adjustments are made as needed to align with the database's search format. The generalised search string used is:

- "blockchain" AND ("identity verification" OR "KYC") AND (“data communication” OR “data sharing”) AND ("social protection" OR “social safety nets” OR "welfare programmes" OR “social security” OR “poverty reduction” “social insurance” OR “social assistance” OR “in-kind transfer” OR “cash transfer”).

To identify existing implementations and challenges, the following string is also used:

- "case study" AND "blockchain" AND ("identity verification") AND ("social protection").

Filters are applied to limit the search results to specific publication dates (past 5 years beginning 2020 and later), document types (peer-reviewed articles, reports, case studies), and languages (English).

2.2 Inclusion Criteria

To ensure the relevance and quality of the included studies, clear inclusion criteria is established based on focus and the type of publication.

Focus: Studies that explicitly address the use of blockchain technology for identity verification or data communication in social protection programmes. Studies published in languages other than English, or before 2020, and not relating to poverty and blockchain are excluded.

Publication Type: Peer-reviewed academic articles, research reports from credible institutions, and well-documented case studies.

2.3 Data Extraction

Data extraction process is conducted after the relevant studies are identified. Key information extracted from each source include authors and year of publication, publication (journal or conference paper), methodology(ies) employed in the study, findings, conclusion, and gaps and limitations.

2.4 Quality Assessment

The main criteria used for quality assessment are as outlined in Section 2.2. Other criteria for quality assessment are recency and methodologies used in the selected studies. In addition to examination by the authors, Rayyan® [7], a web application, and Microsoft® Excel®, spreadsheet, are used to carefully screen, select and include the studies.

3. Results

This section presents results of the study selection, study characteristics, quality assessment, and review.

3.1 Study Selection

The results of the study selection process are summarised in Fig 1 using the PRISMA 2020 Flow Diagram [8].

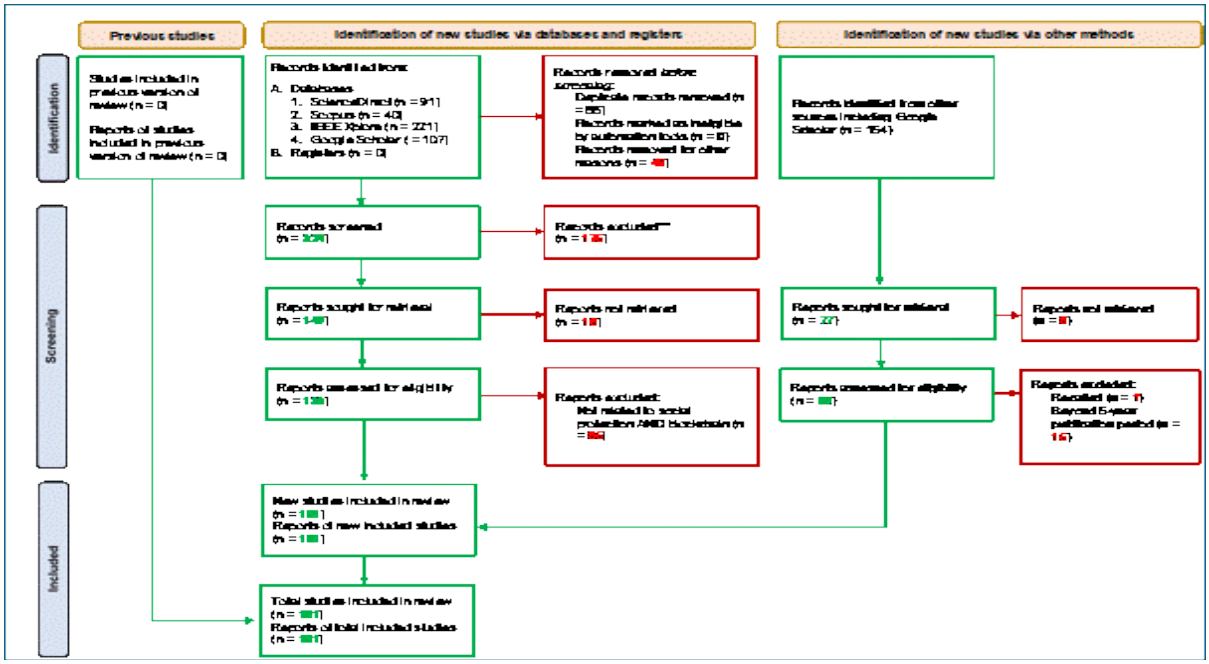


Fig 1: Study Selection Using PRISMA 2020 Flow Diagram

3.2 Study Characteristics

Diversity and Recency of Studies: A total of 101 studies from 69 different publications and 4 academic databases (Fig 2) including other sources are reviewed with each publication having an average share of 1.4 articles. This is to ensure that the findings reflect the popular and current trend in the application of blockchain technology in poverty reduction.

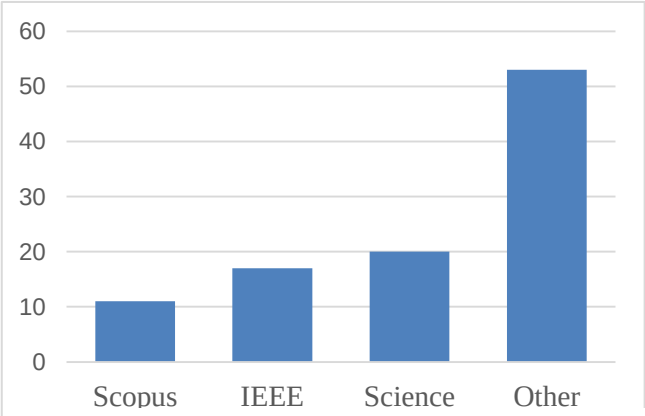


Fig 2: Distribution of Included Studies

Results also show that IEEE Access, Sustainability, Security and Communication Networks, and Sensors are the top-ranking publications in terms of article volume. Table 1 shows the 16 top publications.

Table 1: Top 16 Publications

Publication	Number of Articles
IEEE Access	10
Sustainability	5
Security and Communication Networks	4
Sensors	4
Information	2
Frontiers in Blockchain	2
Future Generation Computer Systems	2
Geopolitics	2
Blockchain: Research and Applications	2
International Journal of Disaster Risk Reduction	2
Wireless Communications and Mobile Computing	2
IEEE Network	2
IEEE Internet of Things Journal	2
Applied Sciences	2
Electronics	2
Computers in Human Behavior	2

Regarding the timeliness or recency of the studies, the years 2022 and 2023 dominate the publication count, with 2022 having the highest number of articles (34%) and 2023 following closely (27%). For visual reference, see Fig 3.

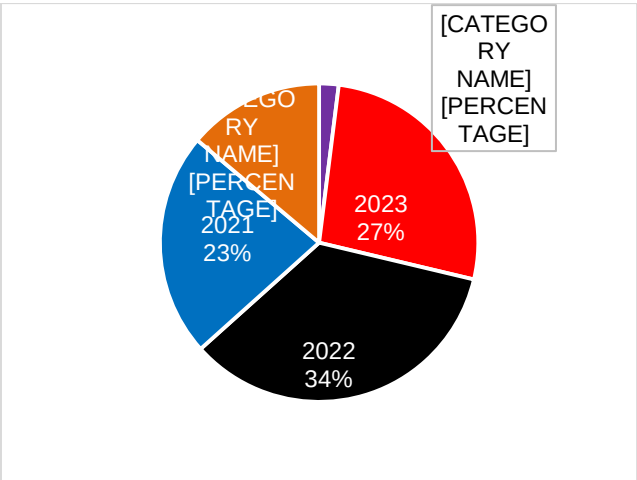


Fig 3: Article Distribution by Publication Year

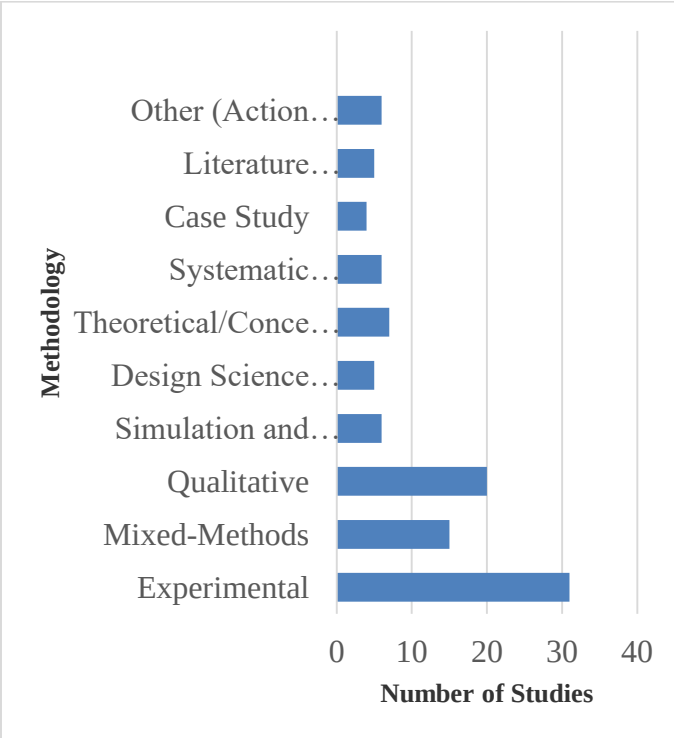
continent of Africa, among others.

Social Protection Programme: No specific programme is in focus, but some studies generally used poverty reduction strategies such as cash transfer, energy subsidy or health insurance as their reference point.

Blockchain Type: Studies included in this review used public, private, consortium, and hybrid blockchains for piloting or modelling.

3.3 Quality Assessment Results

The assessment reveals variability in study design and methodology. Experimental, qualitative and mixed methods have a higher share of studies that used these approaches.



There are overlaps in certain studies. Some studies used multiple methodologies. For example, mixed-methods combining elements of experimental and qualitative. Additionally, certain methodologies are more granular. "Experimental" could encompass various experimental designs. This distribution gives some insights:

- Focus on Validation: The high frequency of experimental methodologies suggests a strong emphasis on testing and validating proposed systems or solutions.
- Real-World Complexity: Mixed-methods approaches are common, demonstrating an understanding that real-world issues often require both quantitative and qualitative perspectives.
- Strong Theoretical Base: Theoretical, conceptual, and literature review methods suggest a foundation in existing knowledge and a focus on developing new concepts or frameworks.

These results suggest a growing trend in the application of blockchain-based systems in improving the efficiency and accuracy of social protection service delivery.

Overall Assessment of Risk of Bias: Based on the identified strengths and weaknesses, the authors of this study assert that the included studies have a low risk of bias, which is unlikely to significantly affect the validity of the findings.

3.4 Results of the Review

Blockchain technology has potential across diverse domains, revealing both promising opportunities and notable challenges.

Analysis shows how recent research extensively explored blockchain technology's potential across diverse domains, revealing both promising opportunities and notable challenges.

Privacy and Security: Studies have demonstrated the effectiveness of cryptographic techniques like ring signatures and lattice-based blind ring signatures in safeguarding user privacy and anonymity in blockchain transactions [9, 10]. Novel approaches for secure access control [11] and privacy-preserving OpenID Connect models based on blockchain have also been developed [12].

Data Management and Authentication: Blockchain-assisted frameworks for secure and efficient internet of things (IoT) data collection [13], peer-to-peer file storage systems [14], and hybrid identity authentication schemes [15] have been proposed. Additionally, user authentication schemas integrating mobile edge computing and blockchain have shown improved efficiency [16].

Sector-Specific Applications: Research has explored decentralized know your customer (KYC) approaches for

microfinance [17], food anti-counterfeiting traceability systems [18], and online document verification using self-sovereign identity technology [19]. Studies have also investigated blockchain's prospects in the insurance industry [20], safe ridesharing [9], and securing data exchange in power transmission systems [21].

Societal Impacts: Studies have also identified a surge in blockchain-based privacy protection techniques during the CoViD-19 pandemic [22], examined the role of digital identification in e-governance [23], and investigated blockchain's potential for financial inclusion in Africa [24].

Challenges and Future Directions: The technical, scalability, and security issues in blockchain smart contract applications [25] have been highlighted, including anonymity challenges in e-cash protocols [26], and the need for inclusivity in the Metaverse [27].

Social Impact and Governance: Conceptual frameworks for implementing blockchain in public distribution systems have been proposed by [28, 29] who also highlighted its potential to address challenges related to the UN Sustainable Development Goals [30].

Data Management and Privacy: Blockchain's role in improving the security and privacy of migrant health data [31], identity management systems [32], and drone communications [33] has been explored. Additionally, blockchain-enabled social security services systems have been proposed [34].

Technical Aspects: Research has delved into the communication resources required for wireless blockchain networks [35], proposed security architectures for IoT [36], and addressed security challenges in blockchain-based services [37].

Social Welfare and Poverty Alleviation: Studies have explored the potential of blockchain in enhancing food supply chains through governmental strategies [38], streamlining green energy financing [39], and establishing zakat collection systems [40].

Data Security and Privacy: The hybridization of zero-knowledge proof and time-based one-time passwords to improve cloud data security has been investigated by [41], while [42] tested the implementation and security of zero-knowledge protocols on self-sovereign identity (SSI) blockchain, and [43] leveraged blockchain for assessing healthcare systems.

Identity Management and Authentication: The harmonization of data systems for cash transfer programming [44], the use of blockchain for creating digital identities for stateless individuals [45], and optimizing peer-to-peer user identity verification in IoT blockchain networks [46] have been investigated.

Diverse Applications: Research has equally reimagined socio-technical economics through distributed ledger technologies [47], introduced programmable money [48], and proposed decentralized Public Key Infrastructure (PKI) frameworks [49]. [See Data Availability].

4.0 Discussion

There is an increasing recognition of the potential of blockchain technology to transform social protection systems, offering solutions to challenges in identity verification, data communication, and programme implementation.

4.1 Summary of Findings

1. Potential Benefits of Blockchain in Social Protection: Blockchain-based identity verification and data communication technologies offer significant benefits for social protection programmes. Research by [9, 10, 11, 12, 50] demonstrates the potential for enhancing privacy, security, and authentication in these programmes. Blockchain's decentralized nature and cryptographic mechanisms ensure secure data communication and protect user privacy, which are crucial aspects of social protection initiatives. Additionally, studies by [13, 14, 15, 16, 51] highlight the efficiency and reliability of blockchain in data management and authentication, particularly in large-scale systems like those required for social protection. Furthermore, blockchain can promote transparency and accountability by creating an immutable record of transactions. This can be particularly beneficial in social protection programmes, where transparency is essential to ensure that funds are distributed to the intended beneficiaries and prevent fraud. This benefit is illustrated in [28]'s proposed framework for the Indian Public Distribution System, which aims to prevent leakage and improve efficiency.

2. Existing Implementations of Blockchain in Social Protection: Although blockchain is a relatively new technology, there are already some notable examples of its implementation in social protection initiatives. The [52]'s Building Blocks project utilizes blockchain to deliver cash-based assistance to refugees, showcasing its potential for improving efficiency and transparency in aid distribution. Additionally, blockchain-based community inclusion currencies (CICs) are being used to address poverty and financial inclusion in marginalized communities, as demonstrated by [53]. Moreover, the use of blockchain for creating digital identities for stateless individuals, like the Rohingya refugees in Malaysia [54], exemplifies its potential to empower marginalized populations and provide access to essential services.

3. Challenges and Considerations for Successful Deployment: Despite its potential, several challenges and considerations need to be addressed for the successful deployment of blockchain in social protection systems. As [25] point out, technical issues, scalability, and security are primary concerns. For instance, blockchain networks must be able to handle the large-scale transactions associated with social protection programmes and ensure the privacy and security of sensitive data. Additionally,

regulatory and legal frameworks need to be established to govern the use of blockchain in social protection.

Another important consideration is the digital divide and inclusivity. To ensure that blockchain-based social protection systems are accessible to all, efforts must be made to bridge the digital gap and provide adequate training and resources to vulnerable populations. Moreover, concerns regarding the anonymity of blockchain transactions [26] need to be addressed to prevent misuse and ensure accountability.

4.2 Strengths and Limitations

4.2.1 Strengths

Breadth of Research: The reviewed literature covers a wide range of topics related to blockchain in social protection, from technical aspects like privacy and authentication to broader societal impacts and specific use cases in different sectors.

Focus on Real-World Applications: Several studies highlight the potential of blockchain to address real-world challenges in social protection, such as financial inclusion, identity management, and data security. The inclusion of case studies and pilot projects provides valuable insights into the feasibility and potential impact of blockchain implementations [19, 22, 24, 52, 53, 55].

Identification of Challenges: The research acknowledges the limitations and challenges associated with blockchain adoption in social protection, including technical issues, regulatory concerns, and the need for inclusivity. This acknowledgment is key for realistic assessment and future development of blockchain solutions.

4.2.2 Limitations

Limited Empirical Evidence: Many of the reviewed studies are theoretical or propose conceptual frameworks, with limited empirical evidence on the actual impact of blockchain in social protection programmes [28, 47]. More real-world implementations and evaluations are needed to validate the proposed benefits and address potential challenges.

Technical Focus: While the technical aspects of blockchain are thoroughly explored, some studies lack in-depth analysis of the social, economic, and political factors that can influence the successful adoption and impact of blockchain in social protection.

Lack of Long-Term Studies: The long-term effects of blockchain implementation in social protection programmes are not yet fully understood. Longitudinal studies are needed to assess the sustainability, adaptability, and overall effectiveness of these solutions over time.

Generalizability: Some studies focus on specific contexts or regions, such as the Indian Public Distribution System [28] or Rohingya refugees in Malaysia. The findings and recommendations may not be directly applicable to other social protection contexts with different challenges and requirements.

4.3 Implications

The findings from this review have implications for both policy and practice of blockchain technology application in social protection.

4.3.1 Policy Implications

Develop Supportive Regulatory Frameworks: Policymakers need to create clear and comprehensive regulatory frameworks for blockchain applications in social protection. These frameworks should address issues like data privacy, security, interoperability, and consumer protection.

Invest in Digital Infrastructure: Governments and international organizations should invest in building the necessary digital infrastructure to support blockchain adoption in developing countries and underserved communities. This includes expanding internet access, providing digital literacy training, and addressing the digital divide.

Promote Research and Pilot Projects: Funding research and pilot projects can help to further evaluate the potential benefits and challenges of blockchain in real-world social protection contexts. This can inform the development of evidence-based policies and guidelines.

Encourage Collaboration: Collaboration between governments, international organizations, Non-Governmental Organizations (NGOs), and private sector actors is essential for the successful deployment of blockchain in social protection. Such collaborations can leverage the strengths of different stakeholders and address challenges collectively.

4.3.2 Implications for Practice

Prioritize User-Centric Design: Social protection programmes using blockchain should prioritize user needs and experiences. This includes ensuring accessibility, ease of use, and adequate training for beneficiaries.

Address Scalability and Interoperability: Practitioners should select blockchain platforms and technologies that can handle the scale and complexity of social protection programmes. Additionally, ensuring interoperability with existing systems is important for seamless integration.

Focus on Data Security and Privacy: Robust security measures should be implemented to protect sensitive personal data stored on the blockchain. This includes using encryption, access controls, and adhering to data protection regulations.

Monitor and Evaluate Impact: Regular monitoring and evaluation of blockchain-based social protection initiatives are required to assess their effectiveness, identify challenges, and inform future improvements.

4.4 Future Research

Further research is necessary for harnessing the full potential of blockchain in social protection. Particular emphasis is needed on exploring lightweight and energy-

efficient blockchain models, along with streamlined consensus mechanisms that address the cost and scalability barriers. Developing robust privacy-preserving technologies that protect sensitive beneficiary data while utilizing blockchain's transparency is another vital area of ongoing development. The social and political ramifications of blockchain projects also warrant consideration, requiring careful planning and collaboration to ensure truly inclusive and sustainable programmes.

While all the limitations mentioned earlier in this study are significant, privacy and data protection represent the most critical obstacles to the broader adoption of blockchain in social protection. Blockchain enhances transparency and thus fosters trust, but social protection involves managing the personal data of beneficiaries, which requires strict privacy and confidentiality. his presents a paradox. The sensitive nature of beneficiary data necessitates robust security measures. Extensive research is required to resolve this transparency paradox, adapt innovative privacy techniques, and develop appropriate regulations. Without these efforts, the long-term success and ethical use of blockchain in social protection are at risk.

5.0 Conclusion

Blockchain technology holds significant promise for transforming social protection systems by enhancing transparency, efficiency, security, and inclusivity. However, successful implementation requires addressing technical, regulatory, and social challenges. Continued research and pilot projects are essential to fully understand the impact of blockchain on social protection and to develop effective strategies for its integration into existing systems.

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Declarations

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