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Blockchain and AI-Based Welfare Aid Traceability Systems: A Detailed Review

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Abstract— *Charitable and humanitarian aid systems face persistent challenges such as lack of transparency, misuse of funds, delayed resource delivery, and declining donor trust. Traditional donation mechanisms are largely centralized and cash-based, making monitoring and accountability difficult. Recent advancements in Blockchain and Artificial Intelligence (AI) have provided promising technological solutions to these issues. This review paper presents a detailed analysis of existing literature on blockchain-based donation systems, AI-driven NGO management tools, humanitarian supply chain technologies, and hybrid blockchain–AI frameworks. The paper systematically examines methodologies, technologies, applications, and performance outcomes reported in prior research. Key limitations and research gaps are identified, emphasizing the need for integrated, intelligent, and scalable welfare aid traceability platforms.*

Keywords— Artificial Intelligence, Blockchain Technology, Donation Management, Resource Allocation, Smart Contracts, Transparency, Welfare Traceability.

I. INTRODUCTION

Non-Governmental Organizations (NGOs) and charitable institutions play a crucial role in addressing social welfare challenges such as poverty alleviation, disaster relief, healthcare support, and education. Despite their importance, many NGOs continue to rely on manual or semi-digital donation systems that lack transparency and operational efficiency. Donors often have limited insight into how their contributions are allocated, leading to mistrust and reduced long-term engagement.

The rapid evolution of digital technologies has created opportunities to redesign traditional donation systems. Blockchain technology offers immutable, decentralized, and transparent record-keeping, while Artificial Intelligence enables intelligent decision-making through data analysis, prediction, and automation. Individually, both technologies have demonstrated benefits in improving accountability and efficiency. However, their combined potential in the humanitarian domain remains underexplored. This review aims to provide a detailed examination of existing research efforts and identify directions for future development.

II. REVIEW METHODOLOGY

This review is based on a comprehensive analysis of scholarly articles published between 2016 and 2024, including journal papers, conference proceedings, and academic preprints. Literature was selected based on relevance to donation transparency, NGO digital transformation, humanitarian logistics, blockchain implementation, and AI applications. The reviewed studies were grouped into four primary categories: blockchain-based donation platforms, AI-enabled NGO systems, humanitarian supply chain technologies, and hybrid blockchain–AI frameworks. This categorization enables systematic comparison and identification of research trends.

2.1 Blockchain-Based Donation and Charity Systems

Blockchain-based donation systems primarily focus on enhancing transparency, traceability, and trust. Most proposed solutions employ public or permissioned blockchains such as Ethereum or Hyperledger Fabric. Smart contracts are used to automate donation recording, enforce predefined rules, and enable tamper-proof fund transfers.

Several studies demonstrate that blockchain significantly reduces the risk of fraud by maintaining an immutable ledger of transactions. Donors can verify donation flows, while NGOs benefit from improved auditability and reduced administrative overhead. Some platforms introduce token-based incentives or reputation mechanisms to encourage donor participation. However, many blockchain solutions remain limited to financial tracking and lack integration with procurement, logistics, and beneficiary verification processes.

2.2 Artificial Intelligence in NGO Operations

Artificial Intelligence has been applied in NGOs to improve efficiency, accuracy, and decision-making. Common AI applications include demand forecasting, donor behavior analysis, beneficiary profiling, sentiment analysis, and chatbot-based assistance. Machine learning models help NGOs predict resource needs, optimize distribution strategies, and evaluate program effectiveness.

Despite these advantages, AI adoption in NGOs faces several barriers. Financial constraints, lack of technical expertise, limited access to high-quality data, and ethical concerns restrict large-scale deployment. Additionally, many AI solutions operate as standalone systems and are not integrated with financial or logistics platforms, limiting their impact on overall transparency.

2.3 Humanitarian Supply Chain Management and Transparency

Humanitarian aid delivery depends on efficient supply chain coordination among NGOs, suppliers, logistics providers, and local authorities. Research in this area highlights challenges such as fragmented information flow, lack of coordination, and weak governance structures. Blockchain-based approaches have been shown to improve information alignment and coordination by providing a shared and tamper-resistant data source. Studies also emphasize that transparency technologies must be complemented by trust-based relationships and collaborative governance models. However, current systems rarely leverage AI for supplier evaluation, demand forecasting, or real-time performance monitoring.

2.4 Hybrid Blockchain-AI Frameworks

Hybrid blockchain–AI frameworks aim to combine secure data storage with intelligent analytics. In such systems, blockchain ensures data integrity and transparency, while AI models analyze data to detect anomalies, predict demand, recommend suppliers, and optimize workflows. Although hybrid approaches are increasingly discussed in recent literature, most implementations remain conceptual or limited to small-scale prototypes. Challenges include system complexity, scalability, interoperability, and integration across multiple stakeholders. Moreover, few studies provide empirical evidence of large-scale deployment in real humanitarian settings.

III. LITERATURE REVIEW

Shelar et al. [1] proposed a centralized digital platform to manage various in-kind donations (food, clothes, blood) for NGOs. The goal is to improve efficiency and reduce scams by replacing manual work with a user-friendly Android application and a server-controlled database.

Balamurugan et al. [2] introduced "WeCover," a platform that uses blockchain to create an incentivized clothing donation supply chain. Donors receive blockchain-based credits for their contributions, which can be redeemed for coupons at local businesses.

Pawar et al. [3] outlined a framework for a donation tracking system using a hybrid architecture that combines a centralized database with a blockchain for critical transactions, using a one-time account address system to protect donor and recipient identities.

Nguyen et al. [4] explored how blockchain can solve trust and cost issues in social crowdfunding through a qualitative case study of three platforms, finding that decentralization enables secure, low-cost, peer-to-peer transactions.

Naiknavare et al. [5] proposed "Charity-Chain," an Ethereum-based platform designed to combat fraud in the NGO sector by creating an immutable public ledger of beneficiaries with unique identifiers.

Almaghrabi et al. [6] detailed a Blockchain-Based Donation Traceability (BBDT) framework using a public-permissioned Ethereum blockchain for critical transactions and off-chain storage (MongoDB, IPFS) for sensitive data.

Yashas et al. [7] presented a quantitative study based on a survey of 147 suppliers in India, finding that effective NGO governance and a positive relationship culture are crucial for fostering supplier engagement.

McGrath et al. [8] studied 12 multinational corporations and found that a relational approach to technology (building trust and partnerships) is more effective than a control approach for achieving deep transparency.

Cordery et al. [9] critically reviewed digital transformation's impact on NGOs, arguing that technology risks worsening social division if not implemented with an inclusive, beneficiary-focused strategy.

Rathi et al. [10] documented the real-world technologies used for knowledge management in over 1,600 Canadian NPOs, finding a pragmatic mix of low-tech and accessible digital tools.

Ji et al. [11] analyzed 1,626 U.S. counties, revealing that community-focused Social Welfare NPOs are positively associated with government hazard mitigation efforts.

Nikita et al. [12] provided a strategic overview of digital transformation for NGOs, outlining key strategies, challenges, and lessons from case studies.

Gunasekaran et al. [13] used a survey of international NGOs to study blockchain's impact on humanitarian supply chains, finding that blockchain significantly improves information alignment and coordination.

Dube et al. [14] investigated factors influencing the adoption of blockchain-based charity platforms using a survey of 374 donors, finding that Performance Expectancy and Trust are the strongest drivers for adoption.

Khanolkar et al. [15] proposed a blockchain-based trusted charity fund-raising platform using Ethereum to create an immutable ledger of beneficiaries.

IV. ANALYSIS TABLE

TABLE 1
SUMMARY OF REVIEWED STUDIES ON BLOCKCHAIN AND AI FOR WELFARE AID TRACEABILITY

Sr. No.	Paper Title (Year)	Technology Used	Application Focus	Key Performance Parameters
1	A Smart Platform for Donation Handling (2020)	Blockchain, Smart Contracts, Ethereum	Donation tracking transparency	Transparency, auditability, trust
2	Implementation of Blockchain Technology in a Donation Supply Chain (2023)	Blockchain + REST APIs, Hybrid architecture	Donation monitoring platform	Data protection, scalability, privacy
3	Tracking Donations of Charitable Foundations Using Blockchain Technology (2021)	Blockchain, Smart Contracts, Ethereum	Donation tracking with donor visibility	Accountability, transparency, donor trust
4	Role of Blockchain Technology in Social Crowdfunding (2021)	Blockchain, Smart Contracts, Qualitative Case Study	Social crowdfunding fraud reduction	Trustworthiness, lower costs, engagement
5	Blockchain Based Transparent and Genuine Charity Application (2022)	Ethereum/Hyperledger, Digital signatures	Preventing beneficiary record duplication	Trust, tamper-resistance, reduced fraud
6	Blockchain-Based Donations Traceability Framework (2022)	Public-permissioned Ethereum, IPFS	End-to-end donation flow tracking	Transparency, traceability, security
7	Supply Chains Collaboration of NGOs: A Supplier Perspective (2023)	Supplier Engagement Models, Governance	NGO-supplier collaboration	Reliability, flexibility, response time
8	Tools and Technologies of Transparency in Supply Chains (2021)	Blockchain, AI, IoT, ERP, QR codes	Supply chain visibility and sustainability	Transparency, sustainability, risk reduction
9	NGO Performance, Governance and Accountability in Digital Transformation (2023)	Big Data, AI, Blockchain, ERP	NGO accountability and governance	Accountability, governance efficiency

10	Use of Technology in NPOs for Knowledge Management (2016)	Donor Management Software, Cloud tools	Donor data management	Knowledge retention, efficiency
11	Varieties of NPOs and Local Hazards Mitigation (2022)	Statistical regression analysis (1,626 counties)	Disaster risk reduction	Regression coefficients reported
12	Digital Transformations in Non-Profit Organizations (2024)	Digital tools, case studies	NGO digitalization strategies	Donor reach, efficiency gains
13	Improving Information Alignment in Humanitarian Supply Chain via Blockchain (2022)	Blockchain + Survey (24 countries)	Humanitarian supply chain tracking	Coordination, trust improvement
14	Factors Influencing Adoption of Blockchain Charity Platforms (2024)	Donor survey (374 respondents)	Donor adoption behavior	Trust, performance expectancy
15	Blockchain Based Trusted Charity Fund-Raising (2020)	Ethereum blockchain	Charity fund-raising transparency	Trust, transparency, lower costs

V. COMPARATIVE ANALYSIS OF EXISTING APPROACHES

Comparative analysis reveals that:

Approach	Strengths	Limitations
Blockchain-Based Systems	High trust and transparency, immutable records, fraud reduction	Lack adaptive intelligence, limited to financial tracking
AI-Driven Systems	Improved efficiency, prediction accuracy, demand forecasting	Data silos, trust issues, lack of transparency
Hybrid Blockchain-AI Systems	Most comprehensive (transparency + intelligence)	Complex design, governance challenges, limited real-world deployment

The analysis also indicates that supplier inclusion, delivery verification, and real-time monitoring are critical yet underdeveloped aspects of existing research. Scalability, interoperability, and regulatory compliance remain significant challenges.

VI. RESEARCH GAPS AND OPEN CHALLENGES

Based on the literature review, the following research gaps are identified:

Gap	Description
Gap 1	Absence of full end-to-end traceability from donor to beneficiary
Gap 2	Limited integration of AI-based fraud detection and optimization models
Gap 3	Inadequate inclusion of suppliers and logistics partners in traceability systems
Gap 4	Lack of large-scale real-world validation of proposed frameworks
Gap 5	Unaddressed ethical, privacy, and regulatory concerns in data handling
Gap 6	Fragmented solutions without unified hybrid blockchain-AI architecture

VII. CONCLUSION

This detailed review examined the role of blockchain and artificial intelligence in improving transparency, efficiency, and trust in welfare aid systems. While significant progress has been made, existing solutions remain fragmented and limited in scope. Integrated blockchain–AI frameworks offer a promising direction for building intelligent, transparent, and scalable donation ecosystems.

Key Findings:

1. Blockchain-based systems excel in trust and transparency but lack adaptive intelligence
2. AI-driven systems improve efficiency but suffer from data silos and trust issues
3. Hybrid systems offer the most comprehensive solution but require careful design and governance
4. Supplier inclusion, delivery verification, and real-time monitoring remain underdeveloped

Future research should focus on real-world deployment, ethical AI implementation, and collaborative governance models to maximize social impact.

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CONFLICT OF INTEREST

The authors declare no conflict of interest regarding the publication of this paper.

REFERENCES

[1] S. R. Shelar, S. R. Salve, A. S. Kedari, “A Smart Platform for Donation Handling,” IJRESM,2020.

[2] N. Balamurugan, S. Rathore, T. Dhir and S. Bajaj, “Implementation of Blockchain Technology in a Donation Supply Chain,” IJRES,2023.

[3] P. Pawar, G. Rajukar and N. Gaikwad “Tracking Donations of Charitable Foundations Using Blockchain Technology,” IJARCCE,2021.

[4] L. T. Q. Nguyen, T. G. Hoang and L. H. Do, “The role of blockchain technology based social crowd-funding in advancing social value creation,” ResearchGate, 2021.

[5] O. S. Naiknavare ,M. P. Patil and R. C. Chawate “Blockchain based Transparent and Genuine Charity Application,” IJRASET, 2022.

[6] A. Almaghrabi and A. Alhogail, “Blockchain-based donations traceability framework,” JKSUCIS, 2022.

[7] S. Yashas, Devendra DN and R. Raghavan, “Supply Chains Collaboration of NGOs:A Supplier Perspective Model,” Preprint Manuscript, 2023.

[8] P. McGrath, L. McCarthy and J. Rehme, “Tools and Technologies of Transparency in Sustainable Global Supply Chains,” California Management Review, 2021.

[9] C. J. Cordery, G. Goncharenko and T. Polzer, “NGO’s performance , governance and accountability in the era of digital transformation,” The British According Review, 2023.

[10] D. Rathi and L. Given, “Use of Technology in NPOs for Knowledge Management,” SSHRC, 2016.

[11] H. Ji and J. Yeo, “The Varieties of NPOs and local hazards mitigation efforts,”JPNA, 2022.

[12] N. A. Nikita, K. S. Azim and A. H. M. Jafor, “Digital Transformations in Non-Profit organizations,” AIJMR, 2024.

[13] R. Gunasekaran , “Improving Information Alignment and Coordination in Humanitarian Supply Chain through Blockchain Technology,” LJMU, 2022.

[14] M. Dube and S. Dube, “Factors Influencing the Adoption of AI Chatbots By Non-Governmental Organizations,” IEOM Society International, 2024.

[15] A. A. Khanolkar, A. R. Gokhale and A. S. Tembe, “Blockchain based Trusted Charity Fund-Raising,” IJSCE,2020.