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Blockchain Ethics in Humanitarian Supply Chain Management

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Abstract

Humanitarian organisations are embracing technology to improve the efficiency of their operations. However, as digital tools are increasingly used, questions have arisen about how beneficiary data is collected, stored, and transferred, and how these practices can be designed to ensure privacy, security, and protection from digital harm. Blockchain technology is argued to solve this issue due to its unique features of immutability and provenance. Its implementation in the humanitarian sector, however, raises ethical concerns for which research has a void. The purpose of this paper is to identify the ethical implications of blockchain technology in humanitarian supply chains. A framework is then provided to showcase how these ethical issues conflict the humanitarian principles of humanity, impartiality, neutrality and independence. The predominant ethical implications of blockchain in humanitarian supply chains are privacy, security, digital divide, data governance, inclusion and equity, regulatory and legal issues, and resource allocation. Blockchain applications promises limitless opportunities, however, balancing the confidentiality needs of beneficiaries like refugees, and the inherent transparency of the blockchain, can be challenging. There is a need to take careful attention in blockchain implementation to avoid ethical risks, as missing the mark could harm the reputation of humanitarian organisations.

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1. Introduction

Each year, global humanitarian needs are increasing because of new and unresolved conflicts, wars, and disasters. The biggest challenge of chronic underfunding is accelerating humanitarian crises, and as a result, humanitarian organisations (HOs) are being innovative in conducting their operations, through measures such as using food banks [1] and cash transfer initiatives [2]. Technological integration like the use of 3D printing, Artificial Intelligence (AI), Virtual and augmented reality, and Blockchain technology (BCT) has been considered in enhancing aid efficiency [3]. With the rise of emerging technologies, academics and policy makers are beginning to question their ethical implications. These discussions are leading to the formulation of ethical guidelines to aid in technology adoption. The ethical implications of AI, for instance, have been documented under eight themes among them, privacy, accountability, safety and security, and human control of technology [4]. In the context of blockchain, ethical questions extend beyond its technical capabilities to their consequences for society. While blockchain offers unprecedented transparency, the same feature can create data privacy dilemmas [2], raising tension between individual autonomy and collective record keeping. This interplay between opportunity and responsibility underscores the necessity of proactive ethical frameworks, ensuring that blockchain's development aligns with human rights and societal values, rather than being driven solely by its unique technical capabilities.

BCT is transforming various sectors such as humanitarian supply chains (HSCs) [5], health care, education, finance and marketing [6], and government and law [7] due to its distinct features of immutability, decentralisation, disintermediation, provenance, and pseudonymity [8]; [9]. In the humanitarian sector, BCT is believed to reduce the challenges of trust, transparency, fraud and corruption that are engraved in the complexities of aid and cash transfers [2]. Despite these game-changing benefits, BCT has received great criticism on its lack of regulations to govern it, its high sustainability costs, coupled with data privacy and security issues [10]; [11]. These shortcomings have necessitated the need to study the ethical implications of BCT. Ethics, studies codes of conducts and morality, which makes individuals, groups and organisations judge what is right and wrong, to ensure conformity to the set behavioural standards of values, morals and conduct [12]. Technological designs embed values that are not always ethical. While technology may appear neutral, these embedded values can have significant moral consequences for society [13]. In the case of blockchain, design choices such as consensus mechanisms inherently reflect particular priorities like transparency and decentralisation. While these priorities are beneficial in certain contexts, they can disadvantage specific groups or conflict with broader ethical principles [13]; [14].

The ethical concerns of BCT implementation are scarcely studied [14]; [6]; [15]). This lack of scholarly attention is problematic given that BCT is still in the development stages and many of its critical design decisions are made by a relatively small group of developers or early adopters, which raises concerns about inclusivity and fairness in representation. Furthermore, contemporary research shows a lack of ethical guidelines for humanitarian blockchain projects [7]; [16]), leaving practitioners without clear frameworks to navigate ethical challenges. HSCs are guided by humanitarian principles that prioritise humanity. Ethical considerations, therefore, cannot be an afterthought, they must be systematically integrated into the design process from the outset, to ensure that BCT progress aligns with humanitarian principles. This paper aims to contribute to the blockchain ethical debate in HSCs by addressing these objectives.

1. To identify the ethical implications BCT poses in HSCs
2. To analyse how these implications conflict humanitarian principles
3. To provide guidelines for ethical implementation of BCT in HSCs

These objectives will help bridge the current gap of slower development of normative frameworks, ensuring that humanitarian blockchain systems serve as tools for empowerment rather than sources of new vulnerabilities. The remainder of this paper is structured as follows. Section 2 elaborates on the foundational principles underpinning HSCs, establishing the conceptual basis for subsequent analysis. Section 3 critically examines the ethical dimensions of BCT, situating them within broader debates on technology stack, governance, and humanitarianism. Section 4 presents a conceptual framework delineating the ethical implications of blockchain adoption in HSCs. Section 5 advances recommendations to guide humanitarian stakeholders in ethically integrating blockchain solutions. Finally, Section 6 synthesises the key insights and outlines the study's conclusions, limitations, and avenues for future research.

2. Humanitarian Supply Chain Principles

The primary goal of HOs is to save lives and reduce human suffering [17], and humanitarian workers gear their efforts towards these objectives. A distinguishing factor between humanitarian and commercial supply chains is the need to uphold humanitarian principles during disaster relief operations. Humanitarian ethics are grounded in four core principles which, as shown in Table 1, are humanity, neutrality, impartiality, and independence [18]. These principles mandate that relief be provided solely based on need, without bias or external influence, thereby establishing a moral compass that is indispensable to the design and delivery of humanitarian operations. The principles also highlight providing aid without discrimination, respecting local culture, involving beneficiaries in decision-making, and upholding accountability to both donors and recipients [18]. These normative principles enable HOs to meet operational objectives such as collaboration, coordination, swift trust, agility, resilience and reliability [9]; [10]; [17]. Digitally enabled systems, such as blockchain, have emerged with the potential to strengthen these operational capabilities; however, their adoption in HSCs raises ethical concerns regarding alignment with the normative principles. The exploration on BCT ethics in HSCs and its alignment with humanitarian principles is provided in this paper. HOs operate in high-stake environments where ethical missteps can have severe consequences for vulnerable populations. Striking a balance between technological innovations and adherence to these principles is essential to ensure the long-term sustainability and legitimacy of HOs.

Table 1. Principles of Humanitarian Supply Chains.

Major HSCs Principles	Meaning
Humanity	Relieve human suffering by protecting life and respecting humans
Neutrality	Humanitarians should not take sides in controversial situations
Impartiality	Prioritise the urgent cases with no discrimination
Independence	Separate humanitarianism from other goals in the target area

3. Blockchain Ethics

A blockchain is a chain of encrypted data blocks where new transactions are added to previous transactions to form a chain of blocks, which are then replicated across multiple connected computers [5]. Members interacting within the BCT network must not know or trust each other since the blockchain is immutable [19]. Over time, developments aimed at achieving selective disclosure in the blockchain have been made through the introduction of permissioned blockchains. This creation of centralisation within the blockchain raises ethical questions: Are there conflicts of interest among network stakeholders that could influence decisions made in the blockchain? As a result, inquiries have been made as to whether it is necessary to have a blockchain code of conduct [14]. The decentralisation of blockchain ensures democracy among participants and can be considered ethical, as it not only allows broad participation from diverse stakeholders but also ensures that there is no single point of control [20]. This feature promotes human rights ethics of freedom and autonomy, as individuals get more control over their data [14].

Other ethical concerns about the blockchain as illustrated by contemporary literature include transparency, immutability and traceability; the technology stack, which includes issues of privacy, accuracy, accessibility, and equality; power, control, and governance; social-economic impacts; and application-specific ethical considerations, such as cryptocurrencies and smart contracts [14]; [15]; [16]; [21]. Blockchain transparency is ethical as it minimises an opportunity for fraud, corruption and resource mismanagement [2]. In HSCs, this openness ensures an ethical use of donor resources. Blockchain encryption and immutability features enhance data security and protection, which promote societal welfare [15]. Blockchain's efficiency in transactions creates value for organisations by boosting their profits, which promotes the societal and environmental interfaces [6]. However, the immutability feature of BCT

creates an ethical tension between privacy and transparency, as records stored on the blockchain are permanent [15]. For HSCs, this permanence could result in the exposure of beneficiary information to unauthorised parties. While encryption, data anonymisation, or the use of permissioned blockchain architectures can mitigate these risks, such measures may reduce some of blockchain's transparency benefits, thereby introducing further design and governance trade-offs [14]; [20].

A critical highlight under power, control, and governance is that the ethical responsibility for BCT ultimately rests with humans and cannot be delegated to technology [14]. Power structures manifest in the form of technocratic control, particularly among developers, as well as social power dynamics resulting from the elimination of intermediaries [21]. These phenomena can lead to a few entities controlling significant computational and non-computational resources. In HSCs, the power dynamics may be prevalent in areas of data ownership and access rights, smart contracts governance, and control over funding budgets, each of which raises profound ethical concerns for operational integrity. Opportunities arise for BCT usage to accelerate social-economic impacts, as it provides access to banking and financial services for the unbanked and reduces transactional costs, and thereby contributes to economic development, which aligns with human rights principles [6]; [13]; [14]. However, the ethical risks arising from its usage include jobs losses due to smart contracts automation, widening social disparities among the rich and poor, which can lead to human rights violations particularly in resource extraction, increased cyber fraud and terrorism facilitated by BCT pseudonymity and sustainability issues stemming from the enormous energy consumption required to mine cryptocurrencies such as Bitcoin [6]; [14]; [15].

Despite the discussions on the ethical implications of BCT outlined above, there is scant literature focusing on blockchain ethics in specific applicational areas beyond finance, such as HSCs. Furthermore, conceptual frameworks for blockchain ethics and systematic ethical analyses in these applicational areas are lacking. This research aimed at filling these gaps by focusing on the humanitarian sector and developing a framework of ethical guidelines for HOs to act upon.

4. Framework

WFP's blockchain project provided a breakthrough for BCT usage in HSCs for cash transfer, but this project has been criticised in violating the humanity, independence and impartiality principle due to scanning of beneficiaries' irises for their identification, and the long-term implication for holding and sharing such data with third party companies, which could compromise data privacy and security of the beneficiaries [22]. Additionally, Bit Pesa that aimed at easy cash transfer to Africa faced legal battles in Kenya due to BCT regulatory concerns, as the lack of blockchain regulations in Kenya could compromise data privacy of beneficiaries [23]. [24] argue that humanitarian experimentation through innovation is increasing, and politics and power dynamics shape the best 'fit' humanitarian subjects for experimentation. This is the case where experimentation of innovation is done in countries with fragile legal institutions. For example, World coin has gained numerous ethical criticisms on collecting iris scans from thousands of Kenyan citizens in exchange of \$50 worth of cryptocurrency, which illustrate an ethical issue of power imbalance and data exploitation. Due to economic vulnerability, most Kenyans signed up without considering what they were agreeing to.

In this paper, the authors argue that the predominant ethical implications of BCT in HSCs are privacy and security concerns arising from BCT transparency and immutability; the digital divide resulting from accessibility issues; data governance challenges related to informed consent, data ownership, and control; inclusion and equity concerns stemming from technological barriers and stakeholders' power dynamics; regulatory and legal issues linked to the decentralised nature of blockchain, which complicates regulatory frameworks; and resource allocation considerations, including the justification of blockchain investment costs and energy consumption, without compromising humanitarian needs, particularly given the often constrained budgets of HOs. These ethical implications are as shown in Table 2. The authors of this paper also develop a novel framework matrix based on the intersection of the six ethical implications of blockchain and the four major humanitarian principles with which they conflict, as shown in Table 2. BCT's guarantee of transparency could expose beneficiaries' sensitive data to exploitation and discrimination, which contradicts the impartiality principle. Additionally, the discrimination means that the vulnerable lives continue to be miserable, which is against the humanity principle. The devices used to access BCT may be vulnerable to security breaches, thus undermining system and data security [25]. The excessive transparency may also lead to data

manipulations and fraud by conflict parties, who may potentially place aid operations as biased, thus undermining the neutrality of HOs. BCT immutability could pose privacy and security concerns to witnesses of conflicts, as their digital identities would remain in the blockchain and could be used against them. While some jurisdictions allow the right to be forgotten achieved by deletion of personal data, blockchain's immutable nature conflicts this right [26].

Table 2. HSC Blockchain Ethics Framework.

Ethical Theme	Sub-themes	Humanitarian Principle Violated
Privacy	Data Sensitivity Immutable Records	Humanity, Impartiality
Security	Fraud Endpoint security	Neutrality
Digital divide	BCT Access Technical literacy	Humanity, Impartiality
Data Governance	Informed Consent, data ownership and control	Humanity, Independence
Inclusion and Equity	Exclusion Fair representation	Impartiality, Humanity, Independence
Regulatory and Legal Issues	Jurisdiction challenges	Neutrality Independence
Resource Allocation	Investment costs Environmental impact	Humanity, Independence

Most humanitarian disasters and conflicts occur in remote and underdeveloped areas that suffer from poor infrastructure and network coverage. This factor limits BCT usage in these areas. Lack of technical skills and digital literacy in these areas upscale the issue [27]. Digital divide often leads to unequal access to aid as priority is given to those with devices and who can use them [28]. This increases the vulnerability of the rest of the beneficiaries, especially the elderly, thus conflicting with the principle of humanity and impartiality. In the Sikka blockchain pilot in Nepal, some of the beneficiaries who subscribed to mobile phones lacked the digital literacy of sending messages or redeeming tokens. Other subscribers needed help to redeem the tokens. Although it is right to assume that the elderly may seek help to redeem tokens from trustworthy friends and relatives, that's not always the case, as these trusted persons may divert the funds to serve their own interests.

HOs may not get the full consent of beneficiaries when collecting their data especially due to cultural and language barriers [29]. In other cases, beneficiaries may consent without getting all the details about their data usage due to fear of not receiving aid. Collecting beneficiaries' data to be fed into the blockchain and sharing it without informed consent undermines their dignity and conflicts with the humanitarian principle of humanity. When dealing with data ownership, questions about who owns the data and who controls it on the blockchain can create ethical dilemmas among HOs, especially where personal data of beneficiaries is involved. Data subjects should have some degree of control over why and how their data will be used [4]. The digital world is, however, far from offering self-sovereign digital identities [27], and if such data is mismanaged, HOs may seek out external data controllers; this dependency may limit their actions, thus undermining their independence.

Design of humanitarian blockchain projects often excludes beneficiaries, and this is insufficient in addressing user-needs [16]. Beneficiaries are often viewed as 'victims' in need of aid, and their exclusion from numerous humanitarian decisions including technological design is unethical, as it undermines their right to participate in decisions affecting their lives, which conflicts the impartiality principle. This exclusion could lead to solutions that are not user-friendly to the very populations they are intended to support, thus accelerating their marginalisation. Additionally, due to the differences of interest among humanitarian stakeholders, there could be chances of unfair decision-making in the blockchain, due to power dynamics, thus conflicting the impartiality and independence principle.

Ethical values should be underpinned in technology design and development and enforced by technology regulation [15]. While countries are continuing to make strides on regulating cryptocurrencies, there generally lacks ethical regulations for their integration with financial systems [21]. Regulation models, if enforced through laws and policies, could aid in solving some blockchain nightmares of privacy and security [25]. Humanitarian aid often involves global operations, thus raising questions on which jurisdiction laws apply to the data stored and transactions conducted in

the blockchain. Who takes the legal responsibility if there is a dispute? In addition, legal frameworks for BCT are still a work in progress in many countries, and this creates uncertainties for developers and users. Ultimately, HOs can get caught up in this legal and sometimes political battle, thus violating their neutrality and independence. HOs operate under constrained budgets [1], and diverting resources meant to meet the most vulnerable needs to implement the blockchain can increase their suffering, thus violating the humanity principle. Moreover, seeking donor funding to implement the blockchain could compromise the independence of HO's particularly if the donor entities seek to influence HO's operations.

5. Recommendations

Table 3 provides a list of recommendations through a list of guiding questions, on the ethical themes outlined in Table 2. As the technology continues to evolve, more of its ethical implications can be added or reduced if solutions to address them are found, providing a comprehensive view for future designers and users of humanitarian blockchain projects. BCT users in the humanitarian sector must rethink how they implement it ethically. A strong justification for its choice, which other technologies cannot do, should be the starting point. Many pilot projects in HSCs that give strong justification for its use have been conducted [16]. As organisations are deciding to go for BCT, the question is then how do they implement it without falling into the ethical pitfalls it may put them in? They need to ask who the developers of BCT are, and evaluate what their values are, as they could be engaging with activities that would lead them to political affiliations and make them compromise their independence. Striking a balance between transparency and privacy is paramount in securing beneficiaries' data and selecting the best blockchain platform to use- whether private or public or a hybrid. The choice on the platform to use will be based on an agreement between network stakeholders on what information should be viewed publicly, and what information should be strictly private, with clear rules on who have access to it, and for how long. These rules will help in maintaining the principle of humanity and impartiality.

Table 3. Guiding Questions on Ethical Implementation of Blockchain in HSCs.

Ethical Theme	Ethical questions to be addressed	Actions by HOs	Related articles
Privacy	Are we collecting only the essential data required for the specific humanitarian operation? Are our encryption methods strong enough to protect in transit and stationary data? Is beneficiary sensitive data only accessible to authorised personnel only?	Collect only the essential data, anonymise data where possible and deploy access control measures for data privacy.	[30]; [26]
Security	Is it possible to anonymise data to protect individuals like refugees? Are plans in place to conduct regular data security audits? Are all devices used to access the blockchain secured with up-to-date security measures? Are there ethical guidelines for disclosure of information without compromising beneficiary safety? How responsive is our incident response plan in addressing data breaches and security incidents?	Train staff on cyber security threats and ethical data sharing. Assess and mitigate system security risks on a continuous basis.	[21]
Digital divide	How can we address the digital infrastructure in remote areas? Are training programs in place to enhance beneficiaries and staff digital literacy skills? Are the devices used to access blockchain user-friendly?	Invest in digital infrastructure and training programs tailored for diverse digital skills levels.	[16]. [31]
Informed Consent,	Are there clear policies on	Collect only essential	[25]

data ownership and control	ensuring informed consent, usage and sharing of beneficiary data? Do beneficiaries have control over their own data? How do we ensure compliance with ethical use of beneficiary data requirements?	beneficiary data, with informed consent, provide ethical guidelines on data ownership rights and control	
Inclusion and Equity	Are we engaging beneficiaries and local communities in the design and implementation of blockchain? Are there mechanisms for stakeholders to provide feedback on the BCT systems? Are the governance structures inclusive of all stakeholders' interests?	Engage users in the design and continuous evolution of blockchain applications Improve blockchain solutions continuously based on users' feedback	[32]; [28]
Regulatory and legal issues	Are we engaging with legal experts to ensure compliance and navigate local and international regulations? Do we have coordination mechanisms to address jurisdictional challenges across borders? Are we maintaining transparency in compliance without violating humanitarian principles?	Engage with legal experts and HSC stakeholders on cross-border humanitarian operations. Uphold humanitarian principles in the design and development of humanitarian blockchain projects	[15] [16]
Resource allocation	Are there enough resources to sustain the blockchain without diverting from essential humanitarian needs?	Conduct a Cost Benefit Analysis for blockchain value. Select BCT platforms that are energy efficient.	[14]

6. Conclusion

Blockchain solutions in HSCs are advancing the ability to send and receive aid and funds in a transparent and efficient way. Unfortunately, they raise ethical concerns on issues of data privacy, security, digital divide, regulations, inclusion, and data ownership and control, thus undermining the humanitarian principles of humanity, impartiality, neutrality, and independence. Selective disclosure mechanisms in the blockchain can be resource-intensive and raise ethical dilemmas, particularly due to the diverse stakeholders in the humanitarian sector, who often have conflicting interests. To reap the immutable trust and provenance benefits of the blockchain that are much needed in the humanitarian world, ethically guided human and technical interventions are required from blockchain designers, developers, and users. The quality of the blockchain is as good as the data fed into it; hence, data collection, blockchain design, and information sharing should be guided by clear and unambiguous ethical standards to prevent ethical washing and ensure the protection of vulnerable populations while upholding humanitarian principles. Cultivating external collaborations with ethics philosophers could be a game changer for developing ethical guidelines for humanitarian blockchain projects.

This paper examined the ethical implications of blockchain technology in the humanitarian sector and proposed a framework to guide its ethical integration in alignment with the humanitarian principles of humanity, neutrality, impartiality, and independence. Despite this novel contribution, the research is grounded in theoretical insights and lacks empirical validation. Future research should validate and fine-tune this framework to generate in-depth insights from humanitarian stakeholders. The ethical themes outlined in the framework also warrant further investigation. For example, in relation to the themes of digital divide and inclusion, the potential for blockchain to exacerbate inequalities, particularly among digitally marginalised populations, remains underexplored. Additionally, a

longitudinal impact assessment of blockchain ethics in HSCs is required to evaluate how ethical risks and benefits evolve over time, and to identify and analyse adaptive governance mechanisms that can safeguard the long-term well-being of beneficiaries.

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