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ENHANCING SUSTAINABILITY IN DISASTER VOLUNTEERING THROUGH BLOCKCHAIN-BASED SYSTEMS: SYSTEMIC CHALLENGES AND STRATEGIC OPPORTUNITIES

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ABSTRACT

Disaster volunteering plays a vital role in rapid emergency response, strengthening local resilience, and enabling collective mobilization during crises. Nevertheless, the continuity and effectiveness of volunteer participation face persistent systemic challenges, including identity verification, task allocation, contribution recognition, motivation, and inter-institutional coordination. This study conceptually explores how blockchain technology—through its decentralized trust mechanisms, immutable data infrastructure, and programmable incentive systems—can enhance sustainability in volunteer management. Using a structured literature review method, academic findings from disaster management, digital governance, and blockchain research were synthesized to identify the barriers at their intersection. Based on this analysis, the study proposes a holistic blockchain-based volunteer management model composed of five integrated components: identity verification, automated task matching, transparent contribution recording, tokenized reward mechanisms, and multi-stakeholder governance structures. The model aims to overcome the current system's deficiencies in transparency, inclusiveness, and accountability while promoting measurable motivation and coordination among volunteers and institutions. Ultimately, the proposed framework contributes to reimagining digital social infrastructure, providing a scalable and trust-based architecture for sustainable and participatory disaster volunteering.

Keywords: *Blockchain, Disaster Volunteering, Sustainability, Volunteer Management*

JEL Classification: *O33, L31, H84, Q54*

BLOKZİNCİR TABANLI SİSTEMLER ARACILIĞIYLA AFET GÖNÜLLÜLÜĞÜNDE SÜRDÜRÜLEBİLİRLİĞİN ARTIRILMASI: SİSTEMSEL ZORLUKLAR VE STRATEJİK FIRSATLAR

ÖZET

Afet gönüllülüğü, hızlı acil müdahale, yerel dayanıklılığın güçlendirilmesi ve krizler sırasında kolektif seferberliğin sağlanmasında hayati bir rol oynamaktadır. Bununla birlikte, gönüllü katılımının sürekliliği ve etkinliği, kimlik doğrulama, görev dağılımı, katkıların tanınması, motivasyon ve kurumlar arası koordinasyon gibi kalıcı sistemsel zorluklarla karşı karşıyadır. Bu çalışma, blokzincir teknolojisinin—merkeziyetsiz güven mekanizmaları, değiştirilemez veri altyapısı ve programlanabilir teşvik sistemleri aracılığıyla—gönüllü yönetiminde sürdürülebilirliği nasıl artırabileceğini kavramsal olarak incelemektedir. Yapılandırılmış bir literatür taraması yöntemi kullanılarak, afet yönetimi, dijital

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yönetişim ve blokzincir araştırmalarına ait akademik bulgular, bu alanların kesişimindeki engelleri belirlemek için sentezlenmiştir. Bu analiz temelinde, çalışma beş entegre bileşenden oluşan bütüncül bir blokzincir tabanlı gönüllü yönetim modeli önermektedir: kimlik doğrulama, otomatik görev eşleştirme, şeffaf katkı kaydı, token tabanlı ödül mekanizmaları ve çok paydaşlı yönetişim yapıları. Model, mevcut sistemdeki şeffaflık, kapsayıcılık ve hesap verebilirlik eksikliklerini aşmayı; gönüllüler ve kurumlar arasında ölçülebilir motivasyon ve koordinasyonu teşvik etmeyi amaçlamaktadır. Sonuç olarak, önerilen çerçeve, dijital sosyal altyapının yeniden tasarlanmasına katkı sağlayarak sürdürülebilir ve katılımcı afet gönüllülüğü için ölçeklenebilir, güvene dayalı bir yapı sunmaktadır.

Anahtar Kelimeler: *Blokzincir, Afet Gönüllülüğü, Sürdürülebilirlik, Gönüllü Yönetimi*

JEL Sınıflandırması: *O33, L31, H84, Q54*

1. Introduction

In the contemporary global crisis environment shaped by climate change, increasing urban density, and socio-political uncertainties, a marked rise has been observed in the frequency, intensity, and unpredictability of disasters. Within this context, the roles assumed by volunteers in disaster response processes have regained critical importance (Whittaker et al., 2015). Particularly in situations where institutional capacities prove insufficient, volunteers are able to provide rapid, flexible, and on-the-ground interventions. Nevertheless, the sustainability of volunteer engagement remains an unresolved issue, not only in terms of quantitative continuity but also regarding systematic integration, accountability, and sustained motivation (Hustinx et al., 2010).

Existing volunteer management models are largely based on centralized structures, with processes such as task assignments, participation tracking, and identity verification predominantly carried out through manual, fragmented, and bureaucratic systems (Kapucu, 2008). This reality hampers effective and swift coordination in disaster environments characterized by high uncertainty, while also conflicting with humanitarian principles such as trust, transparency, and inclusiveness (Fernandez et al., 2006). Digital technologies are increasingly explored as potential solutions to these problems, with blockchain technology in particular gaining attention for its transformative infrastructure in building multi-actor and trust-based systems (Atzori, 2017; Catalini & Gans, 2016). Initially designed as the underlying infrastructure for Bitcoin (Nakamoto, 2008), blockchain has demonstrated applicability across numerous sectors due to its features such as immutability, decentralization, smart contracts, and programmable incentive structures (Tapscott & Tapscott, 2016). Yet, the ways in which blockchain can be theoretically grounded in the context of disaster volunteering and operationalized in practice remain underexplored.

From a theoretical perspective, blockchain technology is argued to provide an architecture aligned with core values essential for sustainable volunteering systems, including resilience, autonomy, and accountability (Dynes, 1994; Twigg, 2009). Through decentralized structures, multi-actor coordination can be enabled even in disaster zones where institutional capacity is limited. With self-sovereign identity systems, the identities and qualifications of volunteers can be securely recorded in a verifiable and privacy-preserving manner (Pava-Díaz

et al., 2024). Smart contracts allow for conditional task assignments and automated reward systems, while token-based incentive structures can enhance motivation and render contributions measurable (Buterin, 2014).

In existing literature, blockchain technology has primarily been examined in contexts such as supply chain management (Saberi et al., 2019; Wang et al., 2019), humanitarian aid distribution (Fan, 2021), and digital identity systems (Knight, 2020). However, its comprehensive integration into volunteering systems has been largely overlooked. Similarly, in the disaster volunteering literature, technological opportunities have not been adequately conceptualized, with emphasis instead placed on sociological, motivational, or logistical barriers (Palttala et al., 2012).

Against this backdrop, the present study makes two core contributions. First, it provides one of the earliest structured attempts to conceptually bridge blockchain technology and disaster volunteering, an intersection that has remained underexplored despite its growing relevance. Second, by proposing a holistic blockchain-based volunteer management model, the study moves beyond isolated technological solutions and instead offers a systemic framework that addresses sustainability through identity verification, task allocation, contribution recording, incentive mechanisms, and multi-stakeholder governance. This dual contribution not only extends the theoretical landscape of digital disaster governance but also delivers actionable insights for policymakers, NGOs, and technology developers seeking to operationalize resilient and trustworthy volunteer infrastructures.

The preliminary value of this research lies in its ability to reframe disaster volunteering from a purely sociological and organizational challenge into a digitally augmented governance problem, thereby offering new avenues for systemic reform. By situating blockchain as both a technological and institutional enabler, the study highlights strategic opportunities for enhancing inclusiveness, transparency, and long-term engagement in volunteer ecosystems, while underscoring the urgency of developing resilient digital infrastructures for volunteer management in the face of increasingly frequent and complex disasters. Accordingly, the findings of this study are expected to inform disaster governance policies, guide NGOs in volunteer mobilization, and provide actionable directions for technology developers and government agencies seeking to institutionalize blockchain-based volunteer management systems.

1.1 Research Objective

This study aims to address the theoretical gap at the intersection of disaster management, digital governance, and volunteer systems. Specifically, it seeks to assess the potential of blockchain technology in enhancing the sustainability of volunteer participation.

The specific objectives of the study are:

- To identify systemic challenges hindering sustainability in disaster volunteering, based on existing literature.
- To propose blockchain-based strategic solutions within a conceptual model framework addressing these challenges.

2. Conceptual Framework

2.1. Disaster Volunteering and Sustainability

During disasters, volunteers provide critical services in areas where formal institutions struggle to reach. However, volunteer participation often demonstrates episodic, reactive, and fragmented characteristics (Whittaker et al., 2015), creating challenges for both operational efficiency and motivational continuity. Literature emphasizes that sustaining volunteering requires the establishment of institutional trust, recognition of contributions, development of feedback mechanisms, and provision of long-term growth opportunities (Hustinx et al., 2010). Nonetheless, current volunteer management systems are observed to fall short in meeting these needs. The tendency of spontaneous volunteers to act outside formal institutional structures during disasters (Fernandez et al., 2006) fosters mutual distrust (Kapucu, 2008). Moreover, the invisibility of volunteer contributions, insufficient utilization of skills, and passive role assignments constitute key factors diminishing the likelihood of re-engagement. In this regard, sustainability is associated not only with continuity but also with recognition of contributions, rights-based participation, and transparent coordination (Clary et al., 1998).

2.2 Foundations of Blockchain Technology and Its Relevance to Disaster Volunteering

Blockchain, developed by Nakamoto (2008), is defined as a digital technology providing a distributed, immutable, and secure record structure (Narayanan et al., 2016). Its core components include immutability, decentralization, transparency, and smart contracts. Through blockchain infrastructures, volunteer systems can utilize self-sovereign identity verification (Pava-Díaz et al., 2024), automate task matching (Buterin, 2014), and record participation and contributions transparently. Furthermore, motivation can be enhanced and contributions made traceable through token- or NFT-based incentive systems (Kleczewski, 2025). The decentralized nature of blockchain is highlighted as a means of mitigating bureaucratic bottlenecks and preventing resource waste commonly observed in conventional disaster management (Tapscott & Tapscott, 2016).

2.3 Intersections of Blockchain and Disaster Volunteering in Literature

Existing academic studies generally treat blockchain technology and disaster response as separate domains. For example, Tapscott & Tapscott (2016) emphasize blockchain's role in transparency and anti-corruption within humanitarian aid systems, while Fan (2021) investigates its use as an accountability and auditing mechanism in donation systems. In the Turkish context, Özdemir et al. (2024) analyzed the transformative impacts of blockchain in social policy at a theoretical level. However, comprehensive blockchain-based models specifically tailored to disaster volunteering remain limited. For instance, Saberi et al. (2019) examined supply chain contexts, whereas Pava-Díaz et al. (2024) focused on the use of digital identities in social assistance. These studies fall short of holistically integrating critical components such as volunteer identity verification, task matching, participation tracking, incentive mechanisms, and inter-institutional coordination.

2.4 Integrated Theoretical Approach

This study examines the integration of blockchain technology into disaster volunteering systems through a three-layered theoretical framework commonly referred to in the literature as the "socio-technical-governance" perspective (Rejeb et al., 2023).

- **Social Layer:** Encompasses volunteer motivations, trust relationships, and recognition of contributions. In disaster contexts, understanding volunteers' motivational structures is crucial for facilitating the adoption of technological solutions (Whittaker et al., 2015).
- **Technical Layer:** Includes the technological tools offered by blockchain—such as self-sovereign identity systems, smart contracts, and token-based incentive mechanisms. These tools strengthen volunteer management by ensuring data security, transparency, and traceability of transactions (Kshetri, 2018).
- **Governance Layer:** Encompasses distributed decision-making mechanisms, multi-actor interactions, and power-sharing. This layer represents blockchain-enabled governance instruments for inclusive and transparent decision-making processes independent of centralized authorities (Rejeb et al., 2023).

This multi-layered framework serves to demonstrate how systemic issues in disaster volunteering overlap conceptually with blockchain-based solutions, thereby bridging technological innovation with societal dynamics in the disaster volunteering ecosystem.

3. Method

3.1. Research Model

This study has been designed as a conceptual inquiry that theoretically explores the potential contributions of blockchain technology to sustainability challenges in disaster volunteering. During the research process, the Structured Literature Review (SLR) method was adopted (Tranfield et al., 2003; Kitchenham, 2004). Through this method, scientific findings obtained from different disciplines were systematically analyzed and synthesized. The study is positioned at the intersection of fields such as digital governance, disaster management, the sociology of volunteering, and blockchain technologies; hence, an interdisciplinary approach was adopted.

3.2. Data Collection and Selection Criteria

In the data collection phase, academic sources published between 2010 and 2024 were searched through Google Scholar databases. Keywords such as "disaster volunteering," "blockchain," "smart contracts," and "token economy" were employed. Only peer-reviewed, English-language publications that addressed blockchain or disaster volunteering within a social systems context were included. Speculative cryptocurrency-oriented content, purely technical architecture-focused works devoid of social context, and non-academic sources were excluded. The initial search yielded 245 studies; following preliminary screening and relevance analysis, 30 sources were selected for detailed examination.

3.3. Data Analysis and Theoretical Framework

The selected studies were analyzed using thematic coding. During the coding process, themes such as systemic barriers to volunteer sustainability, technical advantages of blockchain, digital identity and reward mechanisms, as well as technological adaptation and governance in disaster management were identified. The findings were related through a compatibility matrix to be used in constructing the conceptual model. The theoretical foundation of the study was structured around Organizational Resilience Theory (Lengnick-Hall et al., 2011), the Decentralized Governance Approach (Atzori, 2017), and the Volunteer Functions Inventory (Clary et al., 1998).

4. Findings and Analysis

4.1. Systemic Challenges in Disaster Volunteering

Although volunteer participation plays critical roles during disasters, existing volunteer management systems face various structural problems. It is emphasized that infrastructures necessary to effectively integrate volunteers into the process and ensure sustainable contributions are largely insufficient. These inadequacies have been reported to cause erosion of trust across the system, inefficient utilization of human resources, and a decline in volunteer motivation.

One of the most fundamental challenges is the lack of trust in verifying the identities and competencies of volunteers. A significant proportion of volunteers who quickly arrive at disaster sites participate spontaneously and independently of institutional structures. This situation can lead to assigning responsibilities to unqualified individuals in tasks requiring expertise or excluding competent volunteers from the system (Fernandez et al., 2006). Current systems rely predominantly on manual processes for identity verification, which are not compatible with the rapid dynamics of disasters.

Task assignment processes are similarly structured in centralized and inefficient ways. Particularly in large-scale disasters, when many volunteers simultaneously enter the system, manual matching methods create severe bottlenecks. As a result, volunteers may either be placed in unsuitable tasks or sidelined after long waiting periods. The absence of algorithmic foundations in matching skills with needs, and reliance on intuitive methods, negatively affects the efficient allocation of disaster resources (Kapucu, 2008).

Significant institutional memory problems are also observed in the processes of monitoring and documenting volunteer contributions. In most current systems, only total volunteer hours are recorded, while qualitative data such as types of tasks performed, working conditions, or levels of contribution are not systematically collected. This shortcoming hinders both the tracking of volunteers' development processes and the evolution of institutions into learning organizations. The inability to document contributions in a verifiable way weakens volunteer motivation and fails to satisfy the need for recognition (Hustinx et al., 2010).

On the motivational level, several shortcomings are evident. While the majority of volunteers contribute for ethical, social, or humanitarian reasons, expectations for recognition and rewards arise particularly in long-term and recurring assignments (Clary et al., 1998). However, the incentive mechanisms implemented in existing volunteer systems are mostly symbolic and

are therefore considered inadequate, especially by digital-native volunteers. Weak inter-institutional coordination also stands out as one of the structural problems in disaster volunteering. Independent volunteer databases are operated by different NGOs, government agencies, and international organizations. This results in redundant registration processes and resource waste at the operational level. The lack of data sharing, inability to establish common task pools, and occurrence of task overlaps are cited as factors that reduce the efficiency of response processes (Palttala et al., 2012).

These structural problems are emphasized as critical barriers that not only hinder volunteer management but also negatively affect the overall disaster response process. Therefore, it is evident that volunteer systems must be restructured in a more inclusive, transparent, scalable, and trust-based manner. Within this framework, the potential contributions of blockchain technology will be examined in detail in the next section.

4.2. Blockchain-Based Strategic Opportunities

Blockchain technology offers transformative potential not only in financial domains but also in the restructuring of social systems requiring trust, transparency, and accuracy. In fields such as disaster volunteering, which involve high uncertainty and necessitate the management of multi-stakeholder structures, the structural capacities of blockchain provide a holistic architecture that supports sustainable participation (Ceylan & Işık, 2023).

First, blockchain-based self-sovereign identity infrastructures enable the decentralized verification of volunteers' identity and competency information. It is known that document verification processes, which may take days in traditional systems, can be completed within seconds through digital wallets. This feature presents a significant advantage for rapid and reliable volunteer matching, especially in time-critical disaster scenarios (Pava-Díaz et al., 2024). A second key opportunity offered by blockchain is the automation of task assignment processes through smart contracts. Triggered when specific conditions are met, these blocks of code allow volunteers' skills to be matched with field needs, assigning appropriate tasks to volunteers instantly. This mechanism minimizes human error while enabling fast and transparent task distribution (Buterin, 2014).

The immutability feature of blockchain infrastructures makes it possible to securely record volunteer activities. Each volunteer contribution, along with metadata such as time, location, and task type, can be stored on the blockchain, ensuring high levels of accountability for both volunteers and coordination institutions. These records can be used in volunteer performance assessments and inter-institutional information sharing (Narayanan et al., 2016). Beyond quantitative tracking, qualitative analysis of these records allows contributions to be transformed into digital incentives via token systems. Accordingly, volunteers may receive rewards such as digital badges (NFTs), training opportunities, or equipment support. This ensures continuity of motivation while rendering the volunteer experience recognizable and transferable (Kleczewski, 2025).

The programmability of token systems provides an important opportunity for sustaining volunteer participation. Volunteers can be rewarded not only for performing tasks but also for completing them effectively and on time, actively participating during crises, or recruiting others into the system (Künkül & Durukal, 2025). This transforms volunteering into a mul-

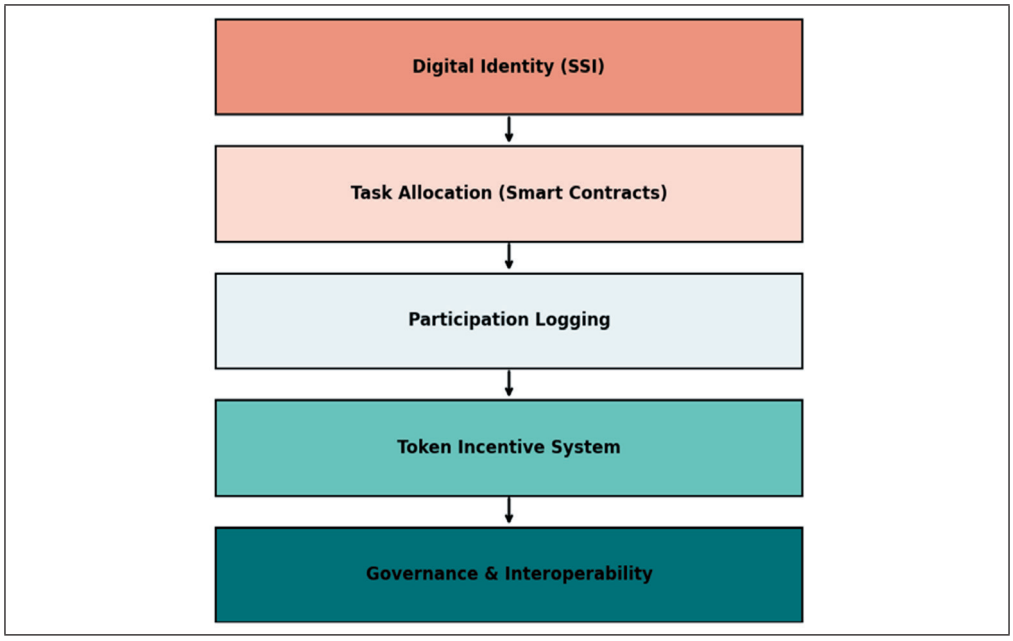
ti-layered, collaborative, and participatory social system (Clary et al., 1998). Finally, blockchain technology facilitates secure data sharing among different institutional actors. Particularly through permissioned blockchain networks, holistic, synchronized, and transparent data coordination can be achieved among government institutions, NGOs, and local initiatives. This reduces data duplication, prevents task overlaps, and strengthens the overall flexibility of the system (Atzori, 2017; Saberi et al., 2019).

All these strategic opportunities demonstrate that blockchain is not merely a technical solution but also provides a governance infrastructure capable of transforming social structures. By exerting profound effects on critical components of volunteer management—such as transparency, accountability, motivation, and coordination—it is argued that blockchain could enable a holistic redesign of disaster response systems.

4.3. Model Proposal: Blockchain-Based Volunteer Management System

Ensuring sustainability in disaster volunteering requires more than just individual motivation or institutional capacity; it also necessitates a trust-based, transparent, and flexible digital infrastructure that bridges these two dimensions. Within this scope, the conceptual blockchain-based model proposed in this study is structured by integrating five core dimensions of volunteer management—identity verification, task matching, participation tracking, incentive systems, and multi-stakeholder governance. The system architecture, consisting of these five layers, is schematically presented in Figure 1. The figure illustrates the components of the proposed architecture, the data flow between layers, and how blockchain technology integrates with these structures.

Figure 1: Blockchain-Based Volunteer Management Architecture



The foundational layer of the model is the identity verification infrastructure, based on the principles of Self-Sovereign Identity. Through this structure, each volunteer can create a digital identity without requiring a central authority and use it within the volunteer system. Identity information is stored on the blockchain in a verifiable manner but is not disclosed unless the volunteer chooses to share it. Thus, volunteers can selectively present their volunteering history and competencies to institutions (Pava-Díaz et al., 2024). This system not only accelerates registration processes but also plays a critical role in establishing mutual trust in volunteer–institution relations.

Built upon this identity system, the task matching mechanism is supported by smart contracts. The system evaluates criteria such as the volunteer's skills, previous contributions, geographic location, and current availability to match them with needs in the field. This matching occurs entirely automatically and does not require any authorization process. In this way, task distribution becomes rapid, fair, and free from human error (Buterin, 2014). Moreover, the matching process is transparent and can be audited when necessary.

Once tasks are completed, volunteer contributions are recorded in the system. Each task is logged on the blockchain with details such as time, location, task type, and, when applicable, supervisor approval. Due to its immutable nature, this record not only ensures trust between institutions but also functions as a digital portfolio that facilitates the volunteer's engagement with different organizations in the future. At the same time, it enables both quantitative and qualitative analyses of volunteering processes. Thus, the system evolves beyond a task distribution tool into a monitoring and evaluation platform (Narayanan et al., 2016).

To make these contributions visible and valuable, the system is supported by incentive and reward mechanisms. After each task, volunteers are awarded a certain number of digital tokens via the blockchain. When accumulated, these tokens can provide access to training resources, equipment support, or symbolic achievement badges (such as NFT-style digital medals). Additionally, based on their contributions, some volunteers may advance into roles such as "coordinator" or "supervisor" within the system (Kleczewski, 2025). This structure holds strong potential to motivate younger users, who tend to perceive volunteering as part of a career development process (Clary et al., 1998).

Above all these layers lies the governance structure, which ensures coordination among different institutions. Unlike traditional centralized systems, the model proposes a distributed network structure in which each institution owns its own data while being able to share information reliably. For example, a task completed by a volunteer at one NGO can be digitally verified by another institution, while private information remains undisclosed to third parties. This architecture is designed through permissioned ledger structures of blockchain technology (Atzori, 2017).

The conceptual model offers a system architecture in which these five layers work together, reinforce one another, and can be updated in real time. From the moment volunteers join the system, all their interactions are recorded; task assignments are carried out automatically; contributions are monitored transparently; and reward processes are linked to objective criteria. At the same time, the entire system is structured under a multi-actor, distributed governance model that is subject to oversight. This holistic structure is both technologically feasible and so-

cially meaningful. By moving away from the fragmented, closed, and manual nature of existing volunteer management systems, it aims to create an open, integrated, and sustainable volunteering ecosystem. The following section discusses the applicability, limitations, and policy-level support required for this model.

5. Discussion

The blockchain-based volunteer management model developed in this study offers a holistic transformation proposal by targeting the structural weaknesses of current systems. The restructuring of five fundamental functions—identity verification, task matching, activity recording, rewarding, and multi-actor governance—through blockchain technology represents not only a technical solution but also a comprehensive redesign of ethical, social, and managerial challenges in the field of volunteering.

This model supports the key themes frequently emphasized in the literature—such as volunteer motivation, continuity of participation, and accountability—through concrete mechanisms (Hustinx et al., 2010; Clary et al., 1998). In particular, self-sovereign identity systems make it possible to reconcile the tension between data security and openness in volunteering. Allowing volunteers to verify their identity by sharing only the necessary information is crucial for protecting privacy (Pava-Díaz et al., 2024). The immutable data structure of blockchain can compensate for the transparency deficits frequently observed in disaster contexts. The auditable recording of volunteer contributions by time, location, and task type strengthens institutional accountability to the public while also making volunteers' contributions visible. This aligns with the "expectation of recognition" particularly evident among younger generations of volunteers (Sharples & Domingue, 2016).

Nonetheless, there are several limitations in implementing the proposed model. The most significant of these is digital inequality. Blockchain systems require infrastructures such as internet access, digital literacy, and mobile device ownership. These requirements can become barriers to volunteer participation, particularly in rural and low-income areas (Dignum, 2019). Therefore, the system must be made flexible through solutions such as offline access, SMS-based identity verification, or simplified user interfaces. Moreover, concerns regarding inter-institutional data sharing may hinder widespread adoption. Especially centralized structures may resist authority sharing and data openness. Hence, blockchain-based systems must be supported not only technologically but also by inclusive governance models. At this point, pilot projects, joint protocol development processes, and community-based decentralized autonomous organization (DAO) structures could facilitate system adaptation (Atzori, 2017; Kleczewski, 2025).

Finally, the technical implementation of this model must also address issues such as energy consumption, scalability, and user experience. Criticisms regarding the energy intensity of public chains like Ethereum highlight the necessity of exploring permissioned and lighter alternatives (Narayanan et al., 2016). Equally important is ensuring that user interfaces are not overly complex and that volunteers are provided with digital literacy content to guide their engagement. Overall, the model aims to integrate technological innovations with the values of the humanitarian field. It redefines volunteering not merely as a reactive practice during crises but as a data-driven, recognized, and supported form of citizenship.

6. Conclusion and Policy Recommendations

Disaster volunteering is a fundamental component that enhances community resilience, strengthens social bonds, and fosters collective reflexes beyond institutional interventions. However, for this contribution to be sustainable and effective, it is clear that existing volunteer management systems require structural reforms. This study has theoretically and conceptually demonstrated how blockchain technology can play a meaningful role in this reform process. The developed model aims to make volunteer systems more flexible, inclusive, and data-driven by restructuring identity verification, task assignment, contribution tracking, rewarding, and inter-institutional coordination processes in a decentralized, transparent, and secure manner. In this respect, it provides not only a framework for disaster volunteering but also a reference model for social services, local initiatives, and digital citizenship applications.

At the implementation level, certain policy steps are required to realize this model. First, pilot projects jointly undertaken by public institutions, local governments, and NGOs should test the model's adaptation capacity. These pilot projects could be applied in limited regional scenarios where volunteers create digital identities, receive tasks via smart contracts, and make their contributions visible. Throughout this process, close monitoring of how volunteers experience the technology, the challenges they encounter, and the components that most effectively motivate them is essential. At the same time, public policy must explicitly emphasize the necessity of supporting volunteering with digital infrastructures. Currently, the Disaster and Emergency Management Authority (AFAD) operates a volunteer pool and provides digital training modules, but these systems do not cover NGO-affiliated or spontaneous volunteers nationwide. More inclusive modules could be developed by integrating with e-Government systems and creating layered structures that not only classify citizens by identity but also record their social contribution history digitally. Such systems would make individuals' social capital visible while enabling data-driven planning processes for institutions.

In the longer term, common protocols and standards must be developed within the volunteering ecosystem. International organizations should provide guidelines to ensure that blockchain-based systems function in line with principles of ethics, security, and inclusiveness. Priority must be given to questions such as who processes the data, under what circumstances it can be shared, and how volunteers' right to exit the system will be guaranteed. Furthermore, a multi-layered incentive and badge system should be established to ensure that volunteers are recognized and visible not only nationally but also internationally. By transparently and verifiably recording volunteer contributions on the blockchain, this system would provide technological visibility and international recognition. Through higher-level badges and statuses, "global volunteer segments" could be created, enabling volunteers to gain identities that transcend national borders. Such a structure would both encourage national volunteers to engage in international volunteering and provide strong motivation mechanisms for volunteers to advance into higher levels within their own countries. Thus, volunteering could be positioned not only as humanitarian aid or crisis support but also as a long-term career and domain of social prestige. The integration of international standardization processes with individual volunteer career pathways would both enhance the sustainability of volunteer labor and strengthen cultures of solidarity and cooperation on a global scale.

In conclusion, this study demonstrates that blockchain technology holds transformative potential in the domain of volunteering. However, realizing this potential requires rethinking not only technology but also ethics, governance, and participation models. Enhancing the sustainability of solidarity and social capacity in the age of disasters will be possible through the human-centered design of digital tools. Blockchain technology, in this vision, serves not only as infrastructure but also as a framework of possibility.

Author Contribution Statement

This is a single-author article, and the entire study was conducted by the author.

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Conflict of Interest Statement

The author declares that there is no conflict of interest in this study.

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