

Decentralized Distribution of Humanitarian Aid for Natural Disaster Relief

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Abstract

Natural disaster is an inevitable phenomenon that results from a significant impact on the entire affected locality. Thus, an effective and efficient humanitarian aid mission is necessary to ensure assistance can be delivered at the right time. The logistics play a central role as the connecting point between preparedness and response with cost-effective flow and storage of relief items and managing related information, including funds from the donors to the beneficiaries. However, lack of communication among humanitarian actors engaged in disaster-relief operations hindered effective and efficient coordination. This paper aims to explore decentralized blockchain technology to cater to the issue.

Keywords: Natural Disaster; Humanitarian Aid, Blockchain

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1.0 Introduction

Natural disasters are catastrophic events resulting from natural causes. Natural disasters are often termed "Acts of God." Climate change is an inevitable phenomenon that has resulted in a significant surge in natural disasters in the world (In Malaysia, the most common natural disaster is floods, mudslides, and landslides, which happen because of heavy rain (Shaluf & Ahmadun, 2006; Yunus, Azman, Isa and Ismail, 2014). The floods in Malaysia are the most common natural disaster which caused by the heavy rain. In Malaysia, the characteristics of rainfall are influenced by two monsoon seasons, i.e. North East (NE) and South West (SW). The months of November to March (May to September) marks the occurrence of NE (SW) monsoon; while inter-monsoon is expected in April and October In 2014, Asia experienced 46 percent of disasters caused by natural hazards globally Muhammad et al, 2000.) The most recent major flood occurred in Peninsular Malaysia was reported in 2014, which affected more than 200,000 people and economic loss of over RM1 billion (Akashah and Doraisamy, 2015). Since 1985 Asia has been the most vulnerable region in the world based on the number of disasters, deaths, the number of people affected, and economic damage, accounting for 50-70 percent of global natural disaster statistics (Guha-Supir, Below and Hoyoyis, N.D). Consequently, the amount of economic and financial losses incurred has significantly increased. Hence, coordination among stakeholders in the humanitarian supply chain (HSC) has been instrumental in solving various disaster-related issues, of which controlling human losses along with a reduction in financial-economic losses are some prominent ones (Sodhi & Tang, 2014). However, the management of humanitarian logistics and supply chain presents significant challenges in distributing aid to disaster victims. Lack of communication and transparency is the most highlighted issue in providing effective and efficient coordination for the mission. In order to guarantee supply chain transparency, a solid trust must be developed among the partners and avoid any mistrust issues related to the products or services in the supply chain. Hence, Blockchain and, more generally, Distributed Ledger Technology (DLT) is a good candidate, which enables the

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complete transparency of data records. This paper will explore the potential adoption of decentralized blockchain technology in distributing aid supply chains for natural disaster relief.

2.0 Categories of Aid for Disaster Victims

Financial aid is offered by various sources to the victims of the disaster (Behl *et al.*, 2019; Wakolbinger *et al.*, 2011), but most financial aid is temporary and short-term (Burkart *et al.*, 2016). Studies have suggested that government is the only body that offers long-term financial support to disaster victims (Burkart *et al.*, 2016; Kunz & Reiner, 2013). Alternatively, crowdfunding is another source of financial aid funded by individual and group contributions via NGOs or through corporate social responsibility (CSR) (Heaslip *et al.*, 2018). There are other sources to offer financial aid, governed mainly by the aim or a motto of an organization or an individual (Kabra *et al.*, 2015; Kovács *et al.*, 2010). While individual and group contributions in the form of direct transfers to the government, non-government organization (NGO), or through corporate social responsibility (CSR) (Heaslip *et al.*, 2018) funded others. As illustrated in Fig 1, there are four main stakeholders for sustainable financial aid for disaster victims (Behl & Dutta, 2019)

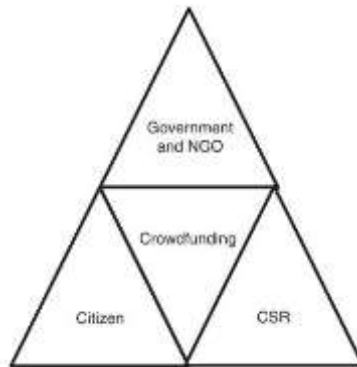


Fig. 1: A triangular approach for sustainable financial aid for disaster victims (Behl & Dutta, 2019)

Other than financial aid, according to the policy of the National Disaster Management Agency Indonesia, there are six guidelines to give aid to disaster victims: (1) a temporary homestay; (2) food; (3) nonfood; (4) clothes; (5) clean water and sanitation; and (6) health services. The six items of aid have minimum standards. As explained in the policy, each item is divided in detail. This is done to match the needs of the victims, aids-organizers, and government. Meanwhile, in India, there is an increase in the investment made toward disaster relief reduction (DRR) by Indian companies (Donaghey & Reinecke, 2018). One of the challenges faced by DRR is multiple degrees of losses caused due to a natural disaster, and the government is the only source of recovery for the affected communities (Sarmiento *et al.*, 2015). It is also claimed that DRR is one such activity that is often supported by CSR funds and organizations. There are companies and CSR organizations as an alternative to government support for disaster relief reduction.

Research has shown that there are many types of aid for the disaster victims, which were discussed in different aspects based on the place where the natural disasters take place. (Kebriyayi *et al.* (2021) stated that the first necessity after a disaster has occurred is medical services and also supplying the relief commodities. In this situation, we need some people to help and treat several injuries as quickly as possible. Staff in the Iranian Red Crescent Society divide into two groups (fixed forces and volunteer forces) to provide relief operations and medical missions, search and rescue. Once a disaster occurs, great demands for medical supplies such as water, food, shelters, medical equipment, and other critical requirements will appear in affected areas and hospitals within a short time. (Kebriyayi *et al.*, 2021)

Table 1: List of aids for disaster victims based on disaster

Natural Disaster	Hurricane Relief	Wildfire Relief	Flood Relief
Aids for disaster victims	<ul style="list-style-type: none"> ● Stock supplies in preparation for hurricane victims ● Establish safe shelters for public safety ● Provide shelter and food until families can return home ● Hand out water, food, and emergency supplies to affected neighborhoods ● Provide medical care for anyone in need ● Give guidance, hope, and comfort to the community ● Provide clean-up supplies ● Assess damage in impacted neighborhoods ● Work with families in developing recovery plans 	<ul style="list-style-type: none"> ● Shelter families ● Serve meals ● Support emergency responders ● Deliver relief supplies ● Provide medical care ● Create recovery plans 	<ul style="list-style-type: none"> ● Provide safe, dry shelter until families can return home ● Serve water and hot meals ● Play with kids staying in shelters ● Ensure people with disabilities get the help they need ● Provide first aid ● Give comfort and emotional support ● Distribute clean-up supplies like mops, gloves, and tarps ● Assess damage in impacted neighborhoods ● Meet with families to prepare recovery plans
Natural Disaster	Earthquake Relief	Winter Storm Relief	Tomado Relief

Aids for disaster victims	<ul style="list-style-type: none"> ● Conduct search and rescue efforts ● Provide medical care ● Serve food and water ● Distribute relief supplies ● Build emergency shelter ● Restore communications ● Restore water supplies ● Teach disaster preparedness ● Rebuild communities 	<ul style="list-style-type: none"> ● Provide meals and snacks ● Provide cleaning and relief supplies ● Provide overnight stays in shelters to families with nowhere else to turn. ● Open cases to provide one-one assistance to help people get back on their feet. 	<ul style="list-style-type: none"> ● Shelter and feed residents ● Distribute clean-up supplies such as shovels, rakes, tarps, and work gloves ● Conduct damage assessment of homes impacted by storms ● Provide mental health support, including counseling for families impacted by storms and tips on self-care and how to cope with the aftermath ● Connect loved ones separated after a storm via services like Safe and Well
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(American Red Cross 2022)

On the NGO websites, all the CSR-related activities and missions are conducted, including the disaster relief operation. There are various types of assistance and aids that are being delivered whenever a disaster occurs, depending on the place and type of disaster itself. The same goes with the American Red Cross volunteer, where the list of aid and missions available based on each possible natural disaster (American Red Cross, 1999). Although most of the aids are the common and most needed aids such as food, medical supplies, and temporary shelter, they have some other great aids to help disaster victims to get back on their feet. The activities are as listed in Table 1.

3.0 Humanitarian Logistics in Disaster Relief Operation

The need to create effective plans for distributing aid after a disaster is of increasing importance in the transport community, as well as segregating the aid relief kit to the victims. Humanitarian logistics profoundly contrasts with conventional logistics activities as the main objective of humanitarian logistics is to offer humanitarian aid in terms of food, water, shelter, and medical services to the affected people. It also emphasizes the response at search and salvage, life-saving and sustaining, and reinstating self-abundance; indeed, even these activities are obstructed by logistical issues, policies related to disaster management, problems in logistics management of humanitarian services, and excess fiscal resources (Thevenaz & Resodihardjo, 2010). According to Lee and Zbinden (2003), logistics management, in any devastating incidents or emergencies, manages the activities of sourcing or procurement, manages the supplies of medicines, food items, clothes, and solicited and unsolicited gifts items donated by various parties/agencies. Besides, it comprises the monitoring and controlling of goods, funds, and information besides the relief aid flow.

Furthermore, Trunick (2005), highlighted that in every humanitarian relief operation, the maximum part (about 80%) of the total effort is covered by the logistics function. The speed of humanitarian aid after a disaster depends on the ability of logisticians to procure, transport, and receive supplies at the site of a humanitarian relief effort (Thomas, 2003). Logistics of essential commodities and rescue operations are the most important activities after any earthquake to prevent the expansion of diseases and reduce the death rate. The greatest demand after a tremendous natural disaster with a lot of casualties happened within the first one or two days. If emergency first aid had been immediately handed out, 25 to 50% of casualties could have been rescued. (Thiel *et al.*, 1992). As described by Daud *et al.* (2016), there are six vital humanitarian logistics management processes which are to provide an adequate supply of commodities of perfect quality, to have proper coordination and prioritization among the usage of limited transportation, appropriate staging, storage, and movement of volume of goods, an effective movement of people to the safest areas and explicit transfer from the outside of the affected area.

In addition, the dynamics of humanitarian logistics are important because disasters have a huge impact on the infrastructure, resulting in disruptions in the supply chains and affecting firms' profitability and performance (Altay & Ramirez, 2010; Simatupang & Sridharan, 2005). Thus, there is a need to understand humanitarian logistics management (Altay & Ramirez, 2010), and it can benefit from the use of wider frameworks of other disciplines (Tabaklar *et al.*, 2015). Many researchers have advocated going beyond the traditional logistics management areas (Buffa, 1980; Ketchen & Hult, 2007) and using alternative theories and methods to explore new dimensions of the impact of supply chain management (Taylor & Taylor, 2009; Moxham & Kauppi, 2014; Halldorsson *et al.*, 2015). Besides, Oloruntoba and Gray (2006), Van Wassenhove, (2006), and Kovacs and Spens (2009) mentioned that the management of humanitarian logistics and supply chain presents significant challenges. The humanitarian system is a complex one; this is determined by a frequently sudden need to re-establish supply chain flows after a disaster and also by the variety of actors involved in the humanitarian aid supply network.

Furthermore, Dwivedi *et al.* (2018) identified how the lack of communication among humanitarian actors who are engaged in disaster-relief operations hindered effective and efficient coordination. These actors can also be broadly different in nature, size, approach, mission, specialization, rules and regulations, and scope of operations. Moreover, a humanitarian system is composed of a number of individualistic actors with self-sufficient perspectives (Maon *et al.*, 2009), and they might become potential "competitors" (Fritz Institute, 2004). The presence of such a high number of differentiated and individualistic stakeholders raises the issue of better coordination of the relief chains and highlights the need for standards able to provide a shared language and shared understanding of procedures and processes.

4.0 Blockchain as Platform for Decentralized Supply Chain

Supply chain management is the integration of material, information, and financial flows in a network of companies or organizations. Multiple supply chain partners need to work together collaboratively to make and deliver products and services to the consumer. The Supply chain management concept fundamentally changes the nature of a firm as control is no longer based on direct control of the internal

business processes but rather based on integration across member organizations in the supply chain (Lai *et al.*, 2004; Porter, 2019). On the other hand, it is stated that the supply chain is a complex system that is composed of many enterprises and is based on information flow to realize the organizational alliance of all the links between enterprises. It is responsible for the circulation of products from the manufacturer to the customer (Leng *et al.*, 2018).

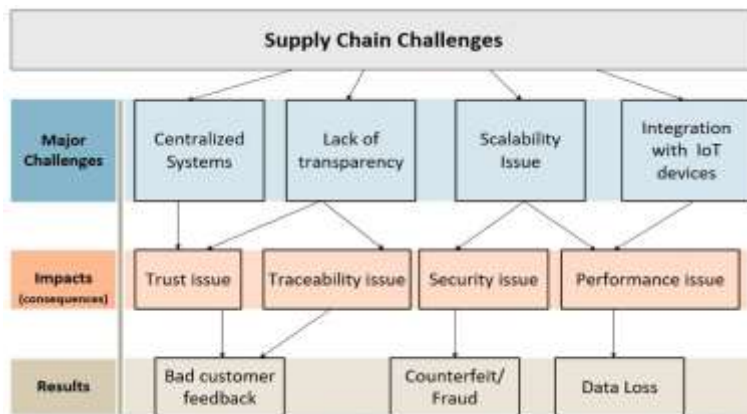


Fig. 2: Technical Supply Chain Challenges (Hellani *et al.*, 2021)

In addition, supply chain collaboration is considered an important factor in achieving a win-win solution for different shareholders in a supply chain (Ramanathan & Gunasekaran, 2014; Tsou, 2013). Based on previous research, one of the significant aspects being highlighted is the transparency of the supply chain in ensuring effective collaboration between enterprises and high-quality products or services. According to Ramanathan and Gunasekaran (2014), there are different forms of supply chain collaboration, including collaborative planning, collaborative decision making, and collaborative execution. Transparency in the supply chain refers to the disclosure of information to trading partners, shareholders, customers, consumers, and regulatory bodies. It captures high-level information along the supply chain, such as product components, suppliers' names, the different locations involved, and associated certificates. (Hellani *et al.*, 2021).

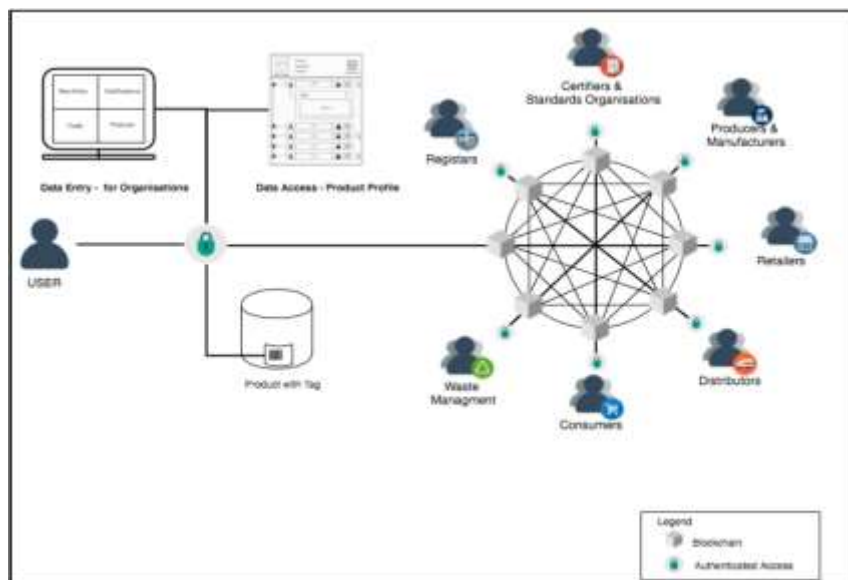


Fig. 3: Overview of Blockchain Manufacturing Supply Chain Concept (Abeyratne & Monafared, 2016)

In order to guarantee supply chain transparency, a solid trust must be developed among the partners and avoid any mistrust issues related to the products or services in the supply chain. At present, the global supply chain consists of a complex network of stakeholders across industries to coordinate collaborative tasks and achieve mutual agreements. Figure 2 depicts the significant supply chain challenges: centralized systems, lack of transparency, scalability, challenges to IoT integration, and the upcoming technologies.

Hellani *et al.* (2021) stated that to overcome the issues related to trust, Blockchain and, more generally, Distributed Ledger Technology (DLT) is a good candidate which enables the full transparency of data records. Blockchain technology is an important distributed secure technology in the prevailing Industry 4.0 era of today and has attracted great attention from both academia and industry (Dobrovnik *et al.*, 2018; Swan, 2017). Blockchain is known as distributed ledger technology (Tschorsch & Scheuermann, 2016; Zyskind *et al.*, 2015), which allows participants to secure the settlement of transactions, archive the transaction, and transfer assets at a low-cost (Tschorsch and

Scheuermann, 2016). According to Wang *et al.* (2021), Blockchain is a decentralized digital ledger that can be programmed to distribute and store data. It is also known as a distributed ledger, which is based on a peer-to-peer (P2P) or decentralized network consisting of a continuous sequence of blocks. Decentralization refers to a situation whereby no single entity controls transaction processing, while distribution relates to the computational work that is divided between several computers (Treiblmaier, 2018).

The basic unit of a blockchain is a single transaction that involves one or more entities. This could be a payment process but might as well be a transfer of information. A new block is connected with previous blocks in a way that makes it increasingly hard to remove from the total chain. (Treiblmaier, 2018). Sophisticated procedures exist to circumvent fraud (e.g., double-spending) which is why it is sometimes written that the Blockchain leads to trustless consensus. An important characteristic of blockchains is their resistance to the modification of data. Transactions on the Blockchain cannot be later modified or removed because of the linking of the blocks together. The longer the chain, the harder it is to make modifications in previous blocks, and thus the higher the level of trust (Narayanan *et al.*, 2016). The fundamental technology of Blockchain has a few main features that can bring significant benefits once, which are decentralization, immutability, security, and smart contract.

For instance, in a Blockchain manufacturing supply chain (Fig 3). The approach comprises a decentralized distributed system that uses Blockchain to collect, store and manage key product information of each product throughout its life cycle. This creates a secure, shared record of exchange for each product, along with specific product information (Abeyratne & Monafared, 2016).

5.0 Humanitarian Disaster Aid Relief Logistics Management on Blockchain

In managing the logistic of aid distribution for the natural disaster victim, transparency is the key to trust as well as accelerating the communication among all parties involved in the aid relief mission. Thus, Blockchain could be one of the approaches to facilitate the cycle in the aid distribution supply chain. The traditional humanitarian logistic supply chain consists of 7 steps (Fig 4), which start from planning and preparedness, assessment, resource mobilization, procurement donations, transport, and execution, tracking, and tracing, stock asset management, extended point of delivery until relief to beneficiaries (Thomas & Kopaczak, 2005)

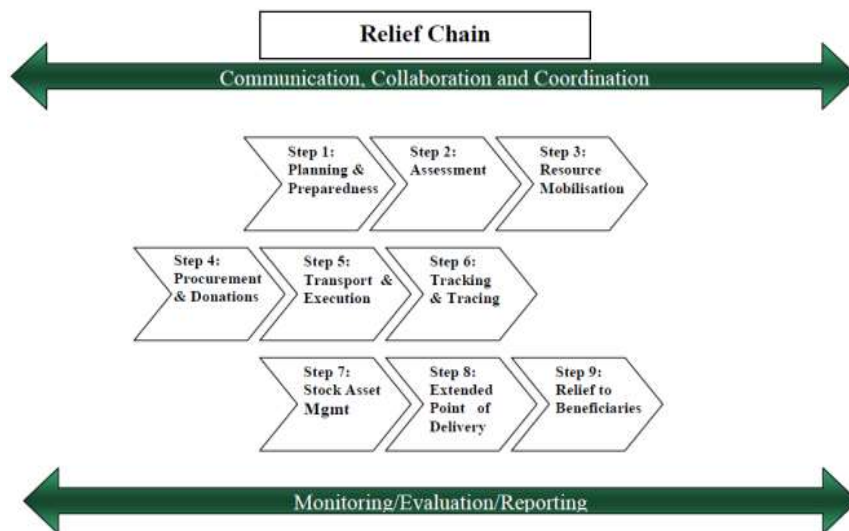


Fig. 4: Humanitarian Logistic Supply Chain (Thomas & Kopaczak, 2005)

The traditional supply chain could be improvised by adopting decentralized blockchain technology, specifically for humanitarian aid relief. Each aid relief could be represented with an information tag that consists of the public and private keys. The public key could be identified as a product I.D. that would be attached with an information tag, which could be in the form of a barcode, RFID, or Q.R. code. This tag represents a unique digital cryptographic identifier that links with the aid provided. This virtual identity is presented on the system software as part of the digital aid profile.

Referring to the nine steps in the traditional humanitarian logistic supply chain (Fig 4), in the blockchain ecosystem, at each step, there is an actor who manages the process at the present stage will have their own digital profile on the network, which is created upon registration. This profile displays information such as their job description, location, and other roles associated with the aid. A product aid that has been signed by an actor would have a link from the product aid profile to the actor's profile. Actors can choose to remain completely anonymous but must be certified by a registered auditor or certifier to maintain the trust in the system.

The system actors in each step must register themselves on the network through a registrar, which is an accreditation service that provides credentials and a unique identity to the actors. Actors can only interact with the network by cryptographically authenticating themselves using their private key. This allows each product aid to be digitally signed by the actors when being exchanged or added further down in the supply chain.

Each actor using this system accesses the specific network of Blockchain through a user interface. The software application used by the actors is configured for a specific digital profile of a product aid. The system is accessible for registered NGOs, organizations, and institutions in the supply chain to download and run on their systems. Hence, all parties could access and track the product aid logistic

movement from the beginning till the relief of aid to the beneficiaries from this blockchain system. In turn, it could promote a harmonized and transparent medium of communication between all parties involved in the humanitarian aid relief mission.

6.0 Conclusion and Recommendation

Humanitarian aid relief for a natural disaster is an important mission to ensure sustainability for the victims. Hence the logistic planning for the aid distribution is vital. Blockchain technology has been widely used in many supply chain management, including in the manufacturing and agriculture industries. However there is limited exploration of this technology in the management of the humanitarian mission. Hence, in future it would be a great advantage to adopt and adapt the current blockchain framework for logistic management in designing the humanitarian aid distribution.

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Paper Contribution to Related Field of Study

This research paper contributes to the field of Library and Information Management.

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