Implementation of Blockchain in the Humanitarian Supply Chain- Benefits and Blockades

Utkarsha Khadke[1], Shilpa Parkhi[2]

[1] Symbiosis Institute of Operations Management, Nashik, Symbiosis International (Deemed University), Pune, India.

[2] Professor & Deputy Director, Symbiosis Institute of Operations Management, Nashik, Symbiosis International (Deemed University), Pune, India.

Email: [1]khadke.utkarsha@siom.in, [2]deputy.director@siom.in

ABSTRACT

Management of humanitarian supply chains have been a complex task due to multiple challenges arising due to the government regulations, lack of supplies, delayed deliveries, etc. With the advent of a major humanitarian crisis brought by COVID-19, a lot of significance have given to managing the humanitarian supply chains in a modernized way. Though humanitarian supply chain is not a new concept yet the adoption of blockchain into its operations is gaining momentum. This paper aims to establish how the blockchain tehnology can be implemented in the humanitarian supply chain and its operational benefits by throughly understanding the major contributing factors to the success of the humanitarian supply chain by analysing its distribution channel, stakeholders involved and challenges that needs to be alleviated. In this paper, we have also discussed the major barriers in the execution of this technology into these supply chains by analysing the complexity of the humanitarian supply chain and the existing literature for the same.

Keywords

Humanitarian supply chain, Blockchain technology, Information flow in humanitarian supply chain, Characteristics of Blockchain, Barriers of Blockchain

Article Received: 10 August 2020, Revised: 25 October 2020, Accepted: 18 November 2020

Introduction

Humniarian supply chains are complex by design and difficult to manage due to the uncertain environment that it functions in. Even though it is different from commercial supply chain in various aspects, yet it is possible to apply certain management technologies which are used for commercial supply chains to the humanitarian supply chains as well. Recently, due to the global crisis developed by COVID-19, a lot of emphasis has been given by governments and organizations from all over the world on the critical management of the Humanitarian supply chains. Even though a lot of information and frameworks are available for the same, yet certain challenges still exist when it comes to execution. These drawbacks affects all the stakeholders involved and hampers the global development.

Blockchain is an emerging technology and have wide applications due to its characteristics such as data decentralization, immutable ledger, improved transparency, etc. Yet, organizations find it difficult to execute this technology due to certain organizational, operational and technical barriers.

Considering these circumstances, we have tried to analyse and discuss the existing frameworks of humanitarian supply chain and the various flows of information and material associated with it. By studying those, we have identified the challenges in management of these supply chains and how blockchain can help in resolving them for smooth functioning. In this review, the advantages of implementing blockchain due to its wide applications as well as the barriers associated at the ground level implementation are discussed throughly by studying the characteristics of blockchain and obstructions involved.

Literature review

Humanitarian supply chain has been in discussion for over past decade and a lot of research have been done to improve its performance and sustainability. (Dubey, 2014) attempted to separate the operational processes involved in the humanitarian supply chain management from normal supply chain management and found agility, alignment and adaptability to be the major success factors for this supply chain. To identify the major factors contributing to the success of any humanitarian supply chain and to interpret their interdependency an ISM approach was used (Yadav, 2015). Further study was done using fuzzy MICMAC to analyse factors and their dependency on each other for a flexible humanitarian supply chain. Government policies, strategy and infrastructural planning; and continuous evaluation of the projects turned out to be the critical factors for the same (Singh, 2018).

Application of blockchain into various fields have been a topic of research for the past few years. This technology lied in its niche stage but is gaining momentum into supply chains because of the improved traceability, data security and digitisation of the supply chains that improved trust among the participants in the supply chain (Wang, 2018). Considering the complexities involved in the humanitarian supply chain, the researchers found as to how its integration with IoT and Blockchain can benefit the stakeholders and enhance the supply chain process performances and its impact (Aranda, 2019). Logistics formed a strong link for a successful humanitarian supply chain and researchers found the benefits of introducing blockchain based smart contracts to facilitate distribution of supplies and ensure swift trust among collaborators (Baharmand, 2019). In order to identify the scope and take the research on blockchain further,

(Dubey, 2020) formulated six research hypotheses and found that blockchain technology improves the operational efficiency of supply chain by increasing the transparency and thus, the trust among collaborators. Even though most of the researchers believed in the advantages of blockchain in the relief supply chain, they also implied on certain barriers when it came to its implementation. Using the fuzzy Delphi method and best-worst method, 9 major barriers were identified and the respective weightage to these barriers was established. Lack of knowledge and training of employees, changes in regulations and high sustainability costs were found out be the major barriers in Blockchain adoption (Sahebi, 2020).

Humanitarian Supply Chain

Humanitarian supply chain is the progression of alleviation help and the connected data between the victims suffering by the debacle and the contributors to limit human anguish and deaths. The primary focus for it is to acquire the necessary resources, transport them and successfully deliver them to the victims' areas.

Humanitarian supply chain is integral to disaster alleviation for the below mentioned reasons:

• It is the costliest piece of any help activity and the smooth functioning of it can determine if the relief activity was successful in its execution.

• It fills in as a link between disaster readiness and reaction, between suppliers and the distributors.

• It is essential to provide quick reaction and carry-on efficient operations for significant humanitarian projects, for example, providing basic necessities such as food, safe house, water and hygiene facilities to the affected people.

• It can provide significant information for performance estimation to give post-project learnings in order to improve continuously.

Humanitarian Distribution Channel

Relief aid distribution channels like every other channel present the course of material, data and one-sided stream of funds from benefactors. These streams forms a foundation for any supply chain network and are characterized as logistics, data and financial streams (Wang, 2019). These streams in a normal Humanitarian Supply Chain, are portrayed in the figure 1. It starts with monetary and logistics streams from particular benefactors until the resources are shipped to arrive at the recipients. Simultaneously, data is created at demand zones and sent to the individuals involved, which also covers benefactors. Generally, the data has been separated by the management and dispersed through mass correspondence channels. This method of data sharing is changing with the rise of social media, due to which the presence of the intermediaries are becoming pointless in data management through different data channels.

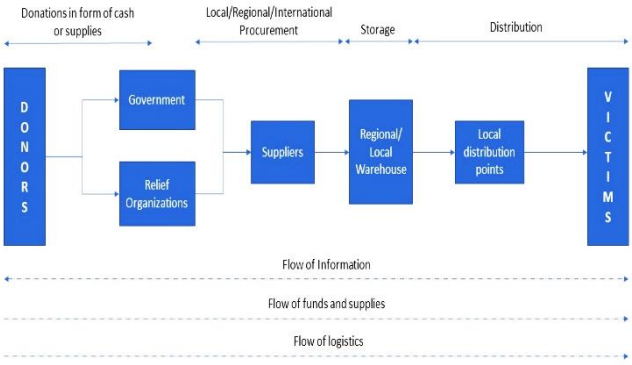

Figure 1: Flows in a normal Humanitarian Supply Chain

Postponements with respect to supplies are brought about by lack of forecasting, restricted accessibility of vehicles and states of the disaster, though deficiencies of aid happen generally due to restricted accessibility of data, improper assessment of requirement and inadequate supplier management. In different cases, nonetheless, even the stakeholders and their ineffective and hasty decisions can hamper the entire supply chain functioning. Delays due to longer lead times, lack of availability of items and abundance of low-need items occur widely during disasters due to flawed transportation framework and demand vulnerability (Narayanan and Robinson, 2013).

The data management in this supply chain includes estimation and checking of the real-time situations, data sharing and coordination among associations involved, and sharing the amount of funds to be raised to the donors. Disaster circumstances establish an ambience lacking correspondence infrastructure and solid data. Consequently, coordination has been distinguished as a significant question. The huge number of stakeholders included and the dubious number of self-initiated members make it imperative to have an effective coordination among them via proper data management (Whybark et al. 2010). The lack of coordination can result in the excessive supply of resources or conflicts over similar supplies.

In this supply chain, it can be observed that there is a critical progression of cash towards the distressed zone caused due to the disasters. During such emergencies, the administration of monetary assets steeply affects the victims. Researcher have found a few inadequacies in the past experiences. The transparency of monetary funds is usually poor in these settings. Regardless of the significance of acquiring and tracking materials during calamity reaction, researchers have recognized defilement and frauds in procurement, distribution of supplies, and absence of responsibility coming from the administration of monetary flows (Schultz and Soreide, 2008). Owing to these frauds, the victims are affected the most due to lack of amenities and the supplies are not utilized for the expected purposes, leading to a reduction in trust from the contributors.

Stakeholders in Humanitarian Supply Chain

The basic framework of a humanitarian supply chain changes as per the type of disaster and locations and thus, the stakeholders involved may vary as well. Some of the common stakeholders are listed as follows-

Disaster Victims- People that endure a disaster have various difficulties hanging tight for them and they need to confront various difficulties under the absence of lack of basic necessities and information. Disaster Victims mean those that experienced a debacle yet figured out how to endure it. At the hour of calamity, saving lives has the most elevated need and thus availabilty of adequate supplies is a must.

Benefactors- Benefactors give the majority of funds needed for significant disaster aid exercises; this involves monetary methods to help humanitarian relief tasks or arrangement of supplies in terms of goods and services for free while performing logistical activities.

Governments- In times of disasters, the administrating government and other helping nations across the globe are the impetuses since they have the ability to approve operations and assemble supplies. Local government authorization is crucial for the inclusion of different nations or else, no other organizations aside from national relief agencies and the military can work. Host governments have the duty to make a move to diminish or moderate the likelihood of disasters. Additionally, the association of different nations is a delicate issue since the aid depends mostly upon the kinds of ties among nations.

Private Organizations- Such organizations can assume the part of suppliers, decision-making authorities or donors. Any private organization can uphold humanitarian logistics by giving monetary commitments to subsidize disaster relief tasks.

Relief organizations- These might be worldwide players, regional organizations and specific to country relief organizations. Governments can moderate the enduring brought about by disasters through relief organizations.

Non-Profit Organizations- Non-profit organizations involve a wide scope of powerful associations right from the worldwide players to small scale and micro-associations formed by nearby locals which are ready to work at the global level. A portion of these is not lasting but rather circumstance based, made to address one specific emergency.

Military- Soldiers are called upon to give essential help, on account of their high arranging and logistic abilities, thus the military has frequently been an exceptionally huge factor.

Major factors contributing to the success of a Humanitarian Supply Chain

In order to find out the applications of blockchain into humanitarian supply chains, we have identified certain key success factors listed below-

Response practices- Quick responses in the complex environment of a humanitarian crisis is a critical factor and can be achieved by continuous improvement in the system. This will ensure preparedness and avoid losses due to previous mistakes.

Resilient Infrastructure- A strong infrastructure is the backbone for any relief activity as it ensures smooth functioning and transfer of funds and resources. Also, a huge investment is done on these assets specifically for storage and fleet management.

Accurate forecasting- In order to receive early warning signals and ensure the availability of required supplies, accurate forecasting is a must.

Government regulations- As a lot of external organizations participate in the humanitarian aid, government regulations need to be precise as continuous changes can affect the coordination among various stakeholders.

Strategic supply chain design- These supply chains need to be agile and have a resilient structure in order ensure the assets availability for the dynamic market and customer demands. The design should be a balance between the long and short term requirements.

Procurement and Inventory management- Identification of suppliers for quick shipment and storage of adequate inventory so as to avoid losses. During relief activities, a Push system is used for central storage and a Pull system is used for dispatch to the affected areas.

Robust technology- Data transfer is imperative in order to assess the needs of the affected regions and to distribute the required supplies to the victims. For this, a robust technology structure is required for an effective response.

Capability building- It includes personnel training, logistics centres, collaboration of various relief agencies and financial institutions, establishing standards and agreements with regional or local governments. This is required to increase the effectiveness of the response processes and efforts.

Challenges in operating the Humanitarian Supply Chain

These supply chains are filled with instability and complexity. Owing to this, keeping the supply chain functioning effectively is a major challenge. In this context, the supply chain coordination might break due to the multiple reasons such as changing government policies, lack of personnel training, etc. Yet some major challenges have been listed in the table as follows-

Sr. No.	Challenges	Reasons
1	Inventory Stock-outs	• Under-stocking of goods due to threat of obsolescence and high storage costs. • High dependency on logistics service provider with inefficient skills. • Inaccurate forecasting methods.
2	Maintaining quality of warehouse	• Lack of facilities in the disaster prone or underdeveloped areas. • Congestions in the warehouse by unplanned deliveries
3	Lack of inter-organizational collaboration	• Due to lack of coordination between various agencies involved. • Difference in documentation standards followed by organizations involved. • Difference in logistics and administration protocols followed at various locations.
4	Lack of long-term planning	• Changing government policies and global regulations. • Issue-related and temporary functioning nature of the relief

		organizations. • Lack of on-ground data to formulate a long-term plan due to data tampering.
5	High resource management costs	• Costs involved with training and upskilling of personnel. • Developing new distribution centers • Financial burden generated by pre-positioned warehouses. • Holding of inventory for longer periods.

Blockchain Technology

The blockchain being the driving technology behind digital currency, like Bitcoin, opened ways for its application in the financial serivices. Later on software experts and business visionaries expressed the huge capability of blockchain to reshape present day monetary, legal and managerial foundations. This technology makes a solid ledger without requesting record managers to manually recognize and depend on external members through changing the focus from the server-based Internet to a cryptographic transparent design. (Wu, 2017).

Moreover, information blocks are put away on a decentralized distributed structure in a blockchain. Hence, any information on the block can't be amended retroactively as each block is recognizable to all members of the organization provided that they are designed to be the participants except if all after blocks are altered in a corrosive manner. Blockchain is characterized as transparent and highly secured distributed storage that lets stakeholders to quickly enter information at whatever point it is required, as it is a decentralized data that stores transactions and shares information across an organization of numerous members and needn't bother with mediators.

Through smart contracts, decision makers will have the option to automatically update and fabricate legally binding arrangements. Basically, blockchain incorporates various current technologies, for example, decentralized handling of data, secure transactions due to cryptography, distributed ledger and a consensus algorithms. This inbuit consensus mechanism will decide to allow members inside its ledger. This mechanism in blockchain can oversee whether a blockchain is public or private. The public blockchain network is an open record which allows anyone to join as contrary to the private blockchain, as it requires approval by another nodes, thus needs consent to enter.

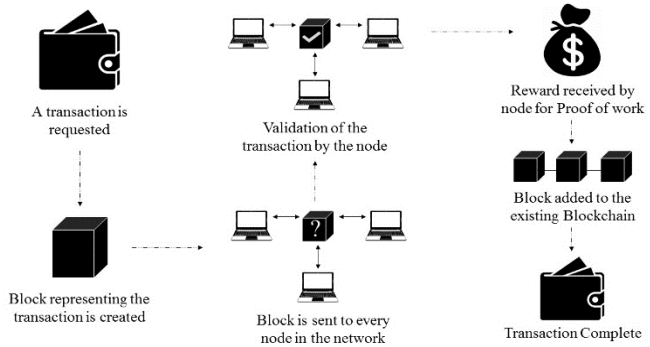

Figure 2: A typical Blockchain transaction

Role of Blockchain to curb the challenges in Humanitarian Supply Chain

Due to involvement of multiple stakeholders and data centralization, researchers have found certain fraud practices in the flow of these supply chains. This issue can be addressed by blockchain as it records and stores all the transactions, and every exchange is shielded from cancellation and amendment. Any alterations made are naturally stored in the block a as new transaction, which are connected to the past exchanges, by the product code in the blocks.

All resources associated with the blockchain network have an indistinguishable duplicate of the ledger in their nodes. This expands the transparency of the exchanges and permits to effectively recognize loopholes in management of the money and the entities associated with the exchange.

This particular characteristic will help in exchanges between parties in the blockchain network even without the presence of any intermediary, which prompts quicker handling times and removes the threat of the information being centralized.The blockchain mechanization thus prompts decreased transaction times.

In the blockchain network, data will be automatically updated after every exchange, which will guarantee that each node in the organization will store a real time copy of the ledger.

Blockchain technology expands the trust among all the partners engaged and it diminishes the processing lead times, which is fundamental for any supply chains.

Moreover, analytics utilized over the data put away in the blocks can possibly better comprehend the flows of cash, which thus will make the efficient distribution of resources (Huckle, 2016).

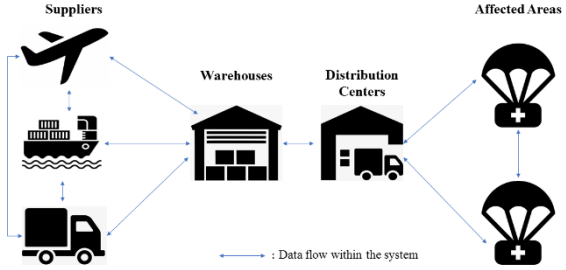

Figure 3: Data flow in a traditional humanitarian supply chain

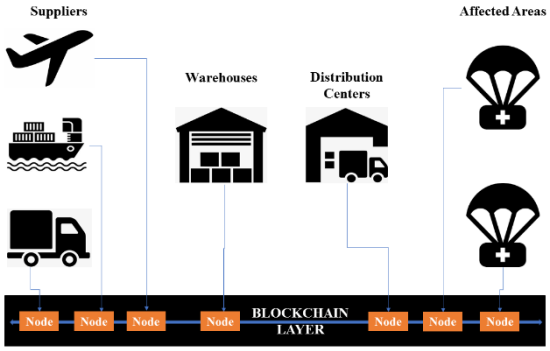

Figure 4: Data flow using a blockchain layer

The following table links the characteristics of Blockchain to its applications in humanitarian supply chain-

Sr. No.	Characteristics	Application in humanitarian supply chain
1	Immutable ledger	• Reduced defilement of supplies and funds due to the consensus mechanism. • Enhanced safety of all the transactions
2	Smart Contracts	• Improved process design for funds transfer. • Improved perceivability due customized agreements for each component of the supply chain & the removal of intermediaries
3	Decentralized data	• Aligned real-time data across all the components of supply chain. • Improved data governance and security of information.
4	Transparency	• Real-time tracking of supplies during a cycle. • Enhanced end to end transparency depending on the consent level through chain of command.
5	Operational Efficiency	• Improved end to end response time for any supply chain measures. • Quick identification of issues and risks to make the flow efficient.
6	Consensus-based mechanism	• Reduced shortages or over-storage of supplies. • Increased trust among all the stakeholders of the supply chain.

Barriers in implementation of Blockchain in Humanitarian Supply Chain

Though the researchers agree that blockchain will change the humanitarian supply chain processes as usual and transform operational practices for an improved outcomes, yet this technology presents numerous challenges when it comes to implementation. These challenges are broadly classified into three categories namely organisational, technological and operational.

Organizational challenges

With respect to the humanitarian supply chain, it is sensible to expect that different intermediaries and a few stakeholders themselves may have dread of being eliminated from supply chains and oppose its implementation. Some stakeholders in supply chain may not need the absolute visibility given by a blockchain. Due to the presence of global organizations and huge transfer of funds and supplies, there might be a reluctance to share esteemed data. This in turn might prove as a hindrance to the implementation of blockchain and affect the supply chain performance.

Technological challenges

The blockchain shields the system from a control by invested parties, and yet this may likewise make issues. Blockchain is seen as an exceptionally secure decentralized information framework, yet hacking is as conceivable. It can happen when a miners briefly command more than 50% of the organization's mining hash-rate. (Yuan and Wang, 2016) For hacking into a public blockchain, there is a requirement for monetary and computational force. Thus, the chances of a private blockchain getting digitally attack is more.

Blockchain lacks the feature to make changes to any transaction but equivalent and inverse transactions could sort records out. In situations with a humanitarian crisis, due to lack of proper infrastructure, smooth data exchange can be hampered as interoperability among blockchains and reconciliation with existing IT frameworks becomes difficult.

Operational challenges

As the humanitarian supply chain functions in a perplexing environment that requires different entities to follow assorted laws, guidelines and foundations, it indeed a real barrier when it comes to enabling blockchain into these systems. The consent of all the stakeholders in supply chain is a must for smooth functioning and adoption of this technology. The blockchain has a characteristic of tamper-proofing and thus provides security for the digital transactions, yet it certain situations it couldn't generally precisely reflect the actual movemet of supplies in the supply chain after proper implementation (Shireesh and Petrovsky, 2016).

It is challenging for organizations having supply chain networks ranging from small-to-medium size organizations to participate, because of their absence of the technical capabilities and monetary requirements. Moreover, due to the shift in data management, the existing operational processes are affected or become insignificant. Chen et al. (2017) brought up issues regarding what information ought to be put away in blockchains, how such information will be gathered and taken care of into the framework and who ought to be accountable.

Adoption of blockchain denotes an absolute transition from the conventional methods of managing supply chains, as trust and authority placed in a decentralized method. The lack of control might be disrupting for some global organizations and entities involved in the humanitarian aid. The existing rigid supply chain operations and the cultural, social and political obstructions will lead to barrier in implementation of blockchain.

As per (Sahebi, 2020), certain operational barriers in their in-depth literature review. These barriers such as scalability, complexity in establishing, technology risks, privacy risks, uncertainty in regulations, high sustainability costs are all applicable to the humanitarian supply chains.

Conclusion

In this paper, we analyzed the existing literature on humanitarian supply chains and studied the basic structure of a typical humanitarian supply chain. We studied its distribution channel by identifying the stakeholders involved and also studied the critical success factors from the previous literature and found some major contributing factors. After studying the design of this supply chain, we identified and narrowed down the major challenges associated with it.

In this paper, blockchain technology and its characteristics have been discussed and its applications in enhancing the humanitarian supply chains have been found out. We also studied how blockchain will enhance the data flow by establishing a blockchain layer and how it will overcome the obstructions associated in the traditional structures. We also tried to discuss the barriers in the execution of blockchain in the humanitarian supply chain which were broadly classified as operational, technological and organizational.

Adoption of blockchain is a complete transition in terms of managing supply chains and thus its implementation posesses huge challenges. Further research on this topic is required that constitutes the real cases of execution of this technology for getting to learn the methods to overcoming the barriers in its adoption so as to improve the operational effciency of a humanitarian supply chain.

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