BLOCKCHAIN FOR IMPROVEMENT OF EMERGENCY RESPONSE IN HUMANITARIAN LOGISTICS INDONESIA

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ABSTRACT

Seven days of emergency response is one of the critical and most dynamics phases of disaster relief for this phase determines the survival rate of disaster victims which rely on coordination amongst all supply chain members. Current technology development, especially blockchain, had enabled supply chain to update and coordinate in real-time while maintaining its accuracy data. Blockchain is expected to improve supply chain performance. However, the application of blockchain is very limited in humanitarian logistics. This conceptual article aims to propose blockchain implementation on the humanitarian logistics performances to increase the efficiency of replenishment operations during disaster emergency relief, especially in Indonesia.

Keywords: humanitarian logistics, replenishment, blockchain

1. INTRODUCTION

Indonesia is a country with a high level of disaster events. According to Indonesia's Disaster Management Agency (BNPB), on average, there were 1803 disaster events happened annually from 2007 to 2017. Besides the high level of a disaster event, Indonesia's Central Bureau of Statistics (BPS) in 2015 had noted a high population density for as much as 134 people per square kilometer. With these numbers, Indonesia has to develop a good disaster management strategy. In several cases, it was found that Indonesia still faces difficulties in disaster management. Lack of disaster relief aid, the uneven disaster support, and some obstacles on logistic distribution have become a serious problem during the emergency response phase in Indonesia. In fact, in several events, some victims of disaster looted the inventory of local minimarket and supermarket to fulfill their needs.

The purpose of humanitarian supply chain is giving a quick response to minimize disaster's impact without compromising cost or funds from donors (Ergun, 2009). The success of a humanitarian supply chain is the extent to which the value of volunteers and donors that could be obtained and the number of victims that could be saved. It is very crucial to understand and to agile adjusting the needs with the type of disaster event, geographical areas, access to the impacted areas, and level of poor damage experienced. In such a dynamic situation, one can be trapped in a trade-off between cost efficiency and decision-making time.

In order to harmonize the activities across the dynamics supply chain, coordination and transparency between parties have become important. Flash Global (2019) had stated that the implementation of certain technologies needs to be done on the supply chain to improve its

performances. Nowadays, Industry 4.0 implies some changes in the way the supply chain works (Tjahjono et al., 2017). Industry 4.0 provides a way to integrate all the processes in the supply chain by using blockchain and the Internet of Things (IoT). Tjahjono et al. (2017) stated that some areas in the supply chain will be affected by the introduction of digitalization and automation of processes by Industry 4.0. The implementation of technology, on the other hand, creates opportunities and threats for each party in the supply chain which depends on how a particular party facing the technology, including for implementing blockchain.

Blockchain is a sharing information system which has a powerful mechanism of transparency data because all system's participant knows all information in the system. Nakasumi (2017) stated that blockchain can be a solution to end asymmetric information of a supply chain, a condition when the parties get different information because of errors in information flow. Asiapost (2019) had mentioned two major sectors, which are banking and creative industry that had been actively using blockchain to increase the performances of their system. Banking Industry uses blockchain to increase security and transparency accounts. Meanwhile, creative industries such as recording companies use blockchain to protect artists' work from piracy. Indonesia has a barrier upon the implementation of blockchain in logistics since there is no national standard of operations (Harsono, 2019). However, some practice of commercial logistics had use blockchain, such as sea transportation (Putri, 2018) and agricultural supply chain in Batam (RTTNews, 2019).

Despite its benefits and shortfalls contrary, the research for understanding the impact of blockchain in the dynamics situation of humanitarian logistics, especially for the disaster management system in Indonesia, is very limited. Thus, research that aims to know the result of a blockchain system implementation on humanitarian supply chain is crucial. The research question addressed in this article is, "Will blockchain create any improvement on the performance of disaster emergency response system in Indonesia?"

This article is divided into four major sections. The first section is the Introduction which reveals the urgency and backgrounds of research. The research methodology is described in section two while in section three, the research results are discussed. The analysis of the results and research limitations are also stated in section three. The last section, the Conclusion, is summarizing this article.

2. RESEARCH METHODOLOGY

This study begins with literature study and an interview to understand the current practice of emergency response phase of disaster relief in Indonesia. Supply chain risk and uncertainty will then be obtained based on the literature survey. Some keywords that are used in this research are humanitarian logistics, disaster relief phase, blockchain and blockchain in logistics. The concept improvement proposal is then developed for the implementation of blockchain.

3. RESULT AND DISCUSSIONS

3.1 Current Practice

Disaster relief distribution system in Indonesia involves many parties such as suppliers, logistics, government, donors (including communities), and the victims. The information about disaster relief distribution system is obtained by interviewing Head of Logistics Department of BPBD and literatures such as Prastyowati (2013) and Hadiguna (2014). The flow of goods and information diagram for current system which had been verified by an expert of BPBD is as seen in Figure 1.

Suppose City X had surrounded by City Y and City Z and was situated away from the capital of its province, where the regional disaster management takes place. Each city had

prepared pre-disaster inventory as calculated by BPBD. Pre-disaster inventory of disaster aid was distributed from regional disaster management to each city. City X was hit by a disaster and demand had received and calculated instantly. City X then would erect a disaster emergency response post nearby the impacted area. This post would be responsible to manage the aids' distribution and victim relocation. Thus, the first response to disaster emergency response post was taken from pre-disaster inventory of City X. If there was any backlog, supported City Y and Z would share some of their pre-disaster inventory directly to the disaster emergency response post. The help from supported City Y and Z was sent based on the instruction from regional disaster management. For further inventory deficiency, regional disaster management would then send inventory directly to disaster emergency response post. Regional disaster management would have the responsibility to make replenishment with their supplier. During the emergency response phase, regional disaster management would not make a replacement to the pre-disaster inventory of City X, since they would send their inventory directly to the impacted area. The regional disaster management would maintain close communication and coordination with disaster emergency response post because the post was having direct contact with the victims.

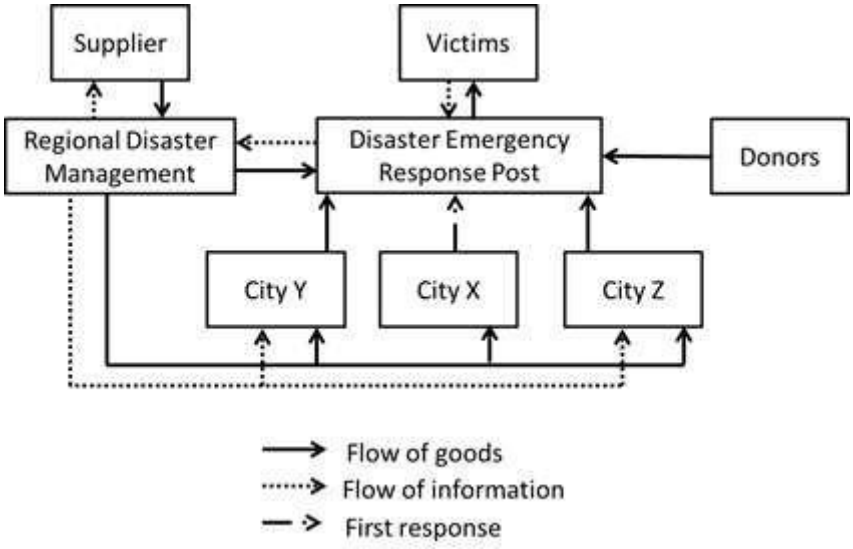

Figure 1. Flow Process Diagram of Current System

3.2 Proposal of Blockchain Transactions Concept for Disaster Relief

The biggest cost of a disaster event is losing a life in emergency response phase. Regional Disaster Management of West Java has a purpose to minimize the death occurs during emergency response phase. The death may occur because of the non-responsive supply chain. As an impact, it's necessary to reduce lead time of material and information to make sure that the response can be done in lesser time and victims could survive from suffering. By using blockchain system, lead time of information sharing can be reduced. Using blockchain, each party would be able to access the same information without the ability to manipulate the data because everyone owns the same record (Nakazumi, 2017). Single information in blockchain is defined by a unique code which differentiates particular information to other information. There is nobody has the authority to maintain a database of information inside a blockchain (Investopedia, 2019) therefore traceability of the system would be symmetrical upon all blockchain system. Responsive supply chain may happen when coordination which supported by transparency data can be achieved (Simchi-Levi et

al, 2008). The challenge can be overcome because blockchain has a mechanism of consensus (or smart contract) which requires members to give approval upon a transaction in instant time, then approved transaction would be encrypted into a block of information and would be shared in the form of general ledger which are accessible for all members in a particular blockchain system. The mechanism of data encrypting through cryptographic would strengthen security system upon the transaction. The summary of challenges in humanitarian logistics replenishment of disaster emergency response and the strategy to cope with the challenges by blockchain are able to see in Table 1.

Table 1. Coordination Challenges in Replenishment of Disaster Emergency Response

No	Challenges	Blockchain mechanism (Nakazumi, 2017; Perboli et al, 2018)
1	ɔn traceability (Thomas & Kopczak, 2005)	Users can not erase the previous block of information in the blockchain (chronological block)
2	Coordination ease and speed (Beamon et al, 2008)	Consensus mechanism (protocol, smart contract) and real-time update (time stamped)
3	Transparency data, inventory positions, robust reporting (Beamon et al, 2008; Arminas, 2005; Thomas & Kopczak, 2005)	● Sharing ledger to the community member inside a blockchain system Fewer intermediary party
4	ibility to respond to uncertainty demand (Habib et al, 2015)	Real-time update of the transaction ledger
5	Security of data and transaction (Setiabudi & Wydiadana, 2019)	● Encrypted data (cryptographically sealed) and consensus mechanism in blockchain (smart contract) Private ledger options

It is clear to see in Table 1 that the blockchain is expected to be able to overcome challenges in humanitarian logistics. The example of proposal of a blockchain mechanism for disaster relief in City X is able to be seen in Figure 2. The system and transaction process overview of the blockchain is a modification of Nakasumi (2017) to match the replenishment operations of disaster relief. In the Figure 2, the flow of information would be flowed in the form of a chain that allows every party involved in the chain to receive any transactions inside the block, the information would not flow through serial parties. Thus, if a supported city (City Y, for example) sends some aid to City X; the supplier, BPBD and authorized party would know instantly in real-time. This would allow them to analyze and adapt their replenishment strategy based on real-time conditions. Moreover, double replenishment of the same type of needs can be avoided.

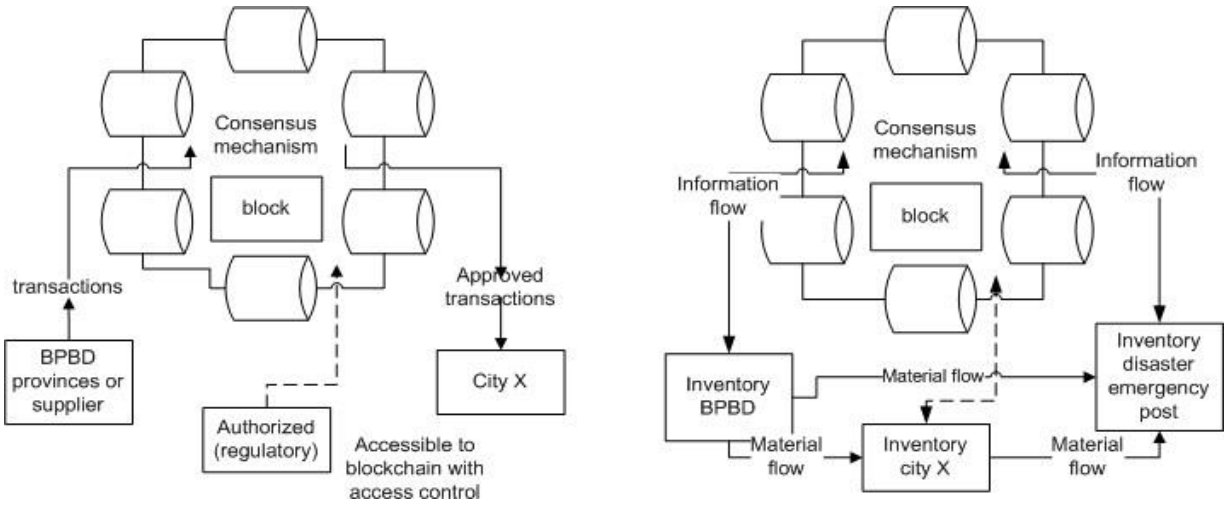

Figure 2. System and Transaction Process Overview of Disaster Relief Blockchain (adapted from Nakazumi, 2017)

Blockchain is suggested to be implemented in a partnership model for disaster relief operational. The partnership model, such as Vendor Managed Inventory (VMI), would develop the basic foundation of trust along with the supply chain alliances (Simchi-Levi et al, 2008) and strengthened the legality of sharing information but still maintaining the segregation of function along the humanitarian supply chain. This means that the supplier may have the flexibility to maintain their business logistics as well as linked in certain humanitarian logistics.

Sharing information and majority consensus (smart contract) are two of the important features of blockchain (Nakasumi, 2017). By such features, we can expect an increment of replenishment efficiency in the practice of humanitarian logistics, which has the high uncertainty order processing lead time. The concept of partnership through VMI allows vendors to puts direct replenishment to buyers without waiting for order first (Angulo et al, 2004). As a consequence, the order lead time and order cost would be diminished, while total replenishment time would be shorter (Waller et al, 1999). However, the vendor would have to receive access to buyers' inventory consumption rate which can be facilitated securely under the platform of blockchain. VMI practices with the support of blockchain technology may become suitable for disaster relief practices.

In humanitarian logistics, the involvement of donors may indeed help the victims, however, the uncertainty of aids' type and value from donors may not be favorable and unreliable, and therefore, sharing information of transaction in the blockchain and even involving donors (public) in the smart contract mechanism would be impractical. Hereby, private blockchain can be a proposal to implement blockchain in the humanitarian logistics. As a consequence, regulatory shall identify decision makers, key actors and key suppliers for each region which would be given permission to access the blockchain.

Blockchain implementation for disaster response shall be supported by internet infrastructure across potential area. Impacted area shall be able to be on-line to access the blockchain system. Currently government's project through Palapa Ring anticipate the internet readiness across Indonesia which its first phase is estimated to be completed by 2020 (Ministry of Communication and Informatics of Indonesia, 2013). An alternative technology that is developed by Indonesia Agency of Technology Assessment and Application would use radio frequency and

Wi-Fi to support the disaster mitigation and response (Agency of Technology Assessment and Application, 2014). Applying both technologies would reinforce the implementation of blockchain.

Since in this study, we only propose the conceptual strategic design of the replenishment system than the operational level of blockchain mechanism, details of blockchain architectures and systems shall be further designed to get the fittest mechanism with operational decisions and security. On the other hand, this conceptual design shall be assessed to match operational decisions, which may be possible by performing a system dynamics simulation. Sterman (2000) confirmed that system dynamics simulation is very suitable in describing the dynamics behavior of systems over time easily. Besiou (2011) had also managed to use a dynamic system for modeling humanitarian logistics.

4. CONCLUSIONS

It is to conclude that the concept of blockchain is expected to increase operations of the replenishment system of humanitarian logistics, especially during seven days of disaster relief. As an implication, further understanding of the specific rule and implementation of the blockchain can be investigated especially by understanding the systemic impact upon the increment operational performances of disaster relief supply chain. It is suggested to perform dynamics system simulation to assess the impact of the strategy upon operational replenishment decisions. It is also suggested to put more emphasis on the design of blockchain ledger and blockchain mechanism that would increase the efficiency yet security of the replenishment system.

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