Usecase of Blockchain in Disaster Management- A Conceptual View

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Blockchain is a distributed database technology where data can be secured with cryptographic function and provide transparency to the system. It has been extensively used in different use cases like financial instruments, egovernance, supply chain and many more. This paper focuses on how blockchain can be used as an application during emergencies. Because, there is no such integrated information system so far developed for disaster management and control for effective decision making. Conceptual model has been developed by reviewing various literature papers from disaster and blockchain streams. This paper tries to address collaborating the stakeholders to one single platform where the information sharing and storing are reliable and consistent. This paper provide a system model for various user scenario in pre, during and post disaster situations. The model claim a holistic view and provide a solution to the disaster events.

Keywords: Blockchain, Distributed Database, Disaster Recovery, Disaster Management, Verification

1. Introduction

Crisis related information is very crucial for any effective decision making. Securing the information against unauthorised access point is much more important. Blockchain technology is a secured database technology which offers distributed data storage, point-to-point transmission, consensus mechanism, and encryption algorithms (Seebacher & Sch, 2017). Itis widely applicable in various fields like financial services(Nguyen, 2016; Cocco, Pinna, & Marchesi, 2017; Egelund-Müller, Elsman, Henglein, & Ross, 2017; Hyvärinen, Risius, & Friis, 2017), healthcare(Mettler & Hsg, 2016; Azaria, Ekblaw, Vieira, & Lippman, 2016), supply chain(Nakasumi, 2017; Wang et al., 2018; Kamble, Gunasekaran, & Arha, 2018), IoT(Reyna, Martín, Chen, Soler, & Díaz, 2018); (Zhang & Wen, 2017); (Zhang & Wen, 2017), privacy rights(Shrier, Wu, & Pentland, 2016), e-governance(Böhme, Christin, Edelman, & Moore, 2015; Atzori, 2017; Santos, 2018), etc where there are multiple parties involved. Blockchain can help the government and society to a large extent during emergencies. Information systems plays a major role in all business sectors where as for disaster management, there is a little usage of information systems.

Disaster management is a complex and chaotic process of recording, processing, storing and disseminating of information to government and public inorder to take timely and effective decisions (Sakurai & Murayama, 2019). It's become difficulty for the government to operate rescue process unless proper information is recorded and maintained. Government can take effective decision like allocation of funds, initiate rescue operation from disaster management team, providing food and shelter, medical and rehabilitation centers, transportation facilities, water and power supplies and other basic amenities for disaster victims and peoples who sourrounds them in all disaster phases such as risk reduction, prepardness, response and recovery.

Technonolgies like Social Networking Services (SNS) (Yin et al., 2015), Open Street Maps, Sensor Networking systems (Erdelj, Król, & Natalizio, 2017), Internet of Things (IoT), Unmanned Aerial Vechicles (UAV) (Erdelj, Natalizio, Chowdhury, & Akyildiz, 2017), Virtual Reality (VR) training system (Li, Liang, Quigley, Zhao, & Yu, 2017) been used in various phases of disaster management. Further, more researches been emerging on technological innovations with respect to crisis management. Risk reduction phase is a proactive approach where it protect, predict and prevent the damages, by using monitoring technologies which show vulnerability of risk by recording real-time information. The main activity of the local authority during prepardness phase is to provide training to people through SNS with VR experience which helps to tackle the disaster. During disaster, situational awarness is most essential. Social media and open street maps enable people to gain situational information. The information system which used in previous stages is required to do recovery operations in an effective manner (Sakurai & Murayama, 2019).

2. Research Gap and Problem

Existing disaster information system have achieved a certain level of automation processing but data captured from various technologies are fragmented in different stages of disaster and no information system employed for connecting supply side and local authorities.There is no consistency and integrity of information maintained as the systems areworking independently (Sakurai & Murayama, 2019). The information in the response stage is much needed for the recovery stage to process the information where identity is the main issue. The risks involved in the existing information system require manual verification of data across various phases hence leads to manipulation, redundant, inconsistent and integrity at any stage of disaster which in turn resulted to misinformation, unreliableand ambigous of information. Due to these reasons, disaster management team is facing challenges to standardise the process and to detect frauds in issue of victim certificates and fund allocations.

3. Objective of the Study

This paper addresses the performance and security of disaster-related information using blockchain technology. The main purpose of blockchain based disaster management solution is – a) to validate the information obtained from various sources, b) integrating the information systems that work independently to achieve transparent, reliable and consistent information,c) to protect and secure the identity and associated disaster related information when issuing victim certificate and d) to provide a cost effective disaster management solution for operational and administrative purposes.

Our contribution towards the paper is the development of conceptual framework of blockchain-based disaster management solution for effcient decision making during risk reduction, prepardness, response and recovery phases. It integrates various communication and sensing technologies(Reyna et al., 2018)along with stakeholders who would like to collaborate with disaster management and recovery process and records their communications for futher verification and processing. Victim certificates will be issued and protected from tampering with the adoption of blockchain technology. The framework is a secured distributed database which comsist of information like relief camp details, victim's demographic details, their health conditions, food and clothing supplies, transportation facilities, energy supplies etc. Blockchain based solution provide a model for early warnings, to communicate concerned authorities and friends for their rescue, to know about the nearest and safest rescue centre, for volunteers to take part into rescue operation effectively. This paper follows research methodology, proposed model for various user scenario, findings and implications of the study.

4. Methodology

This paper follows concept-driven Systematic Literature Review methodology which examines the literature presented by authors in the perspective of concepts based on blockchain. Most of the practitioner and researchers are uncertain about the path of development, especially how these technologies could be incorporated into the existing systemsin the context of disaster management. Based on the literature review, we developed conceptual framework which focuses on disaster management as the key area of research.

5. Related Works

The study uses blockchain technology in the area of disaster management. This section discusses few insights about blockchain technology through literature survey anddiscusses researches related to disaster management. The blockchain is a distributed database linked by a peer-to-peer network which makes the system decentralized and trustless((Böhme et al., 2015). Blockchain holds the decentralized network technology as a distributed database which is the core technology(Glaser, 2017). Each node in the network verifies the transaction using consensus algorithm and sends the information to another node via Public Key Infrastructure to maintain user security, and the transaction will be written in a Block(Glaser, 2017). This technical schema could create blocks through any number of nodes which will be appended to previously created block is called chain of blocks or say Blockchain. Each block that has been created by the nodes contain data of all transactions, hashcode of the current block, hash of previous block and timestamp. All the completed transaction records will be stored on all nodes in the network, which the public ledger. All the nodes in the network can view the transactions in the network. The nodes in the network will be rewarded by verifying the correctness of the transaction which is confirmed through Proof of work algorithm and this process is called as mining; is one of the main concepts of Blockchain Technology. The blockchain is defined as " a distributed database, which is shared among and agreed upon a peer-to-peer network". It consists of a linked sequence of blocks, holding timestamped transactions that are secured by public-key cryptography and verified by the network. Once a new block has appended to the blockchain, it can not be altered, turning a blockchain into an immutable record of past activity (Seebacher & Sch, 2017). Blockchain is the decentralized, distributed network developed for sending and receiving money between users without any third party intermediaries. Blockchain technology eliminates unnecessary intermediaries from the business processes and thereby promotes direct transaction, transparency, trust free and secured data storage.

(Risius & Spohrer, 2017) has established a research framework through his literature survey for the new researches with three groups of activities such as design and feature, measurement and value, management and organization at four level of analysis like user and society, intermediaries, platforms, firms and industry. This helps the researches to explore the area and can deep dive into blockchain technology. Another research focusses on cross boder payments and avoiding double spending during dividend payments for denmark. Using blockchain, one can avoid forging documents and fraudulents payments (Hyvärinen et al., 2017). A comprehensive concept on decentralized energy market and design the system and simulated for 100 residentail households done by (Mengelkamp, Notheisen, Beer, Dauer, & Weinhardt, 2017). This paper emphasis on decentralized local energy market platform where the local energy generation can one without the interference of central intermediary. The decentralized platform for german energy supply system was interconnected by local energy markets and hence distribution can be done. Implementation of such platform can be done through blockchain technology as it offers lots of transparency, security and provide decentralized market design which benefits the society as a whole. (H. Wang, Chen, & Xu, 2016) discusses disruptive technology with lots of features and applicationns , how this blockchain will adopted in an organization. Measuring the matiruty model poses problem in the adoption of technoloy. Before implemeting the technologu, every organization will measure its maturity model to evaluate the degree of development. This paper presents the taxonomy of the maturity assessment which helps to assess the blockchain maturity model. (Tian, 2016)has addressed the problem of agri food supplychain systems at china where the food are perishable which harm peopl's health and destroyed their trust in

domestic food market and have problems such as shortage of funds and equipment, low level of information application, disordered regulatory systems, and lack of monitor-able traceability systems. Due to these reasons food saafety in china was vulnerable in the market. So, to enhance the food safety and reducing the loss of logistic process, they establish a supply chain traceability system based on RFID & Blockchain.(Svein, 2016)look beyond the currency and investigate the potential use of blockchain technology to enable smart government by utilizing the secure, distributed, open and inexpenive database technology. It explains use cases in academic certificate stored on block chain by providing basic requirements for storing academic certificate on blockchain and certain process of storing certificate has also highlighted. This gives future directions for researchers to address the use of bitcoin technology in public sector and in the field of e-Government. (Mettler & Hsg, 2016) has focussed numerous starting points for Blockchain technology in the healthcare industry in this report. With examples for public healthcare management, user-oriented medical research and drug counterfeiting in the pharmaceutical sector, this report aims to illustrate possible influences, goals and potentials connected to this disruptive technology.

(Parra Moyano & Ross, 2017) The authors propose a new system, based on distributed ledger technology (DLT), that reduces the costs of the core KYC verification process for financial institutions and improves the customer experience. This system allows for efficiency gains, cost reduction, improved customer experience, and increased transparency throughout the process of onboarding a customer. (Zyskind & Pentland, 2015) described a decentralized personal data management system that ensures users own and control their data. This paper implemented a protocol that turns a blockchain into an automated access-control manager that does not require trust in a third party. Finally, they discuss possible future extensions to blockchain that could harness them well-rouned solution for trusted computing problems in society. Few other paper discussed the crowd sourcing application in social media which help for disaster management. This paper focussed on the real-timeapplication and highly praised project- the PetaJakarta.org project. They explained the key success factor and the challenges associated with the project. The challengeswere addressed by the social media -based disaster mapping system. (Joseph, Dev, Pradeepkumar, & Mohan, 2018)presents the use of Big Data Analytics and data mining of social media for effective emergency management and its uses during disaster management processes. The power of social media has emerged new field of research which helps to take decision during disasters.

6. Proposed Model

The idea behind our model is to collaborate various stakeholders like government, Non-government, disaster team, transportation, energy, communication services, hospitals, rehabilitation centres, financial services, local government, residents to one platform where information are exchanged and secured for effective management and recovery. The model proposes three stages of user scenario where information is passed on to the local authorities for seeking help and in response, how local authorities can leverage their resources for effective rescue and recovery of the disaster scenario.

User Scenario 1: Receiving earlywarning

The potential cause of disaster and its occurrence and intensity will be forecasted by the disaster team and give alert to the user. The user in the model is the stakeholders collaborated with the blockchain technology. To receive the early warning signal, user need to get registered and authenticate via any one of mode of communication system such as mobile number, email, social media account or create a user account in blockchain platform through certificate authority. Once the early warning is propagated to the blockchain network, it will authenticate the information with the authorized user-say, for example- disaster team, and then disseminate the early warning information to the network. This information will be received by all other users in the network and hence get prepared and planned to overcome the disaster. Figure 1 shows the system model for registration and early warning.

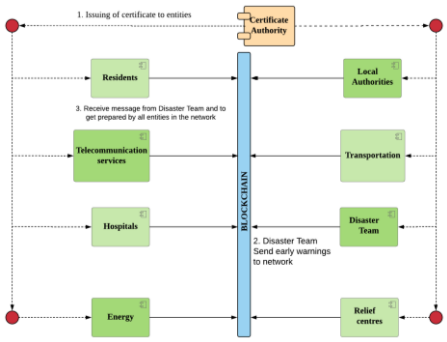

Figure 1 *System Model for Registration and early Warning*

User Scenario 2: User Requesting for Aid

When disaster hits, users request assistance to rescue themselves and their family and friends. Once the request for aid has been made to the network, every stakeholders in the network can access the location, and person or the team near to the location will send an acknowledgement back to the network that the team is ready to rescue. When this acknowlegement receives, with no delay, the respective rescue team will respond to the request and rest of the rescue teams and other

stakeholders can work on other request as well. Since the information is transparent and secured, no data consistency or integrity do occur. Once the rescue team done their emergency operation, the information will be again propogated back to the network for the confirmation of work and the data is stored in the blockchain with timestamp. The system model for rescue aid is shown in Figure 2.

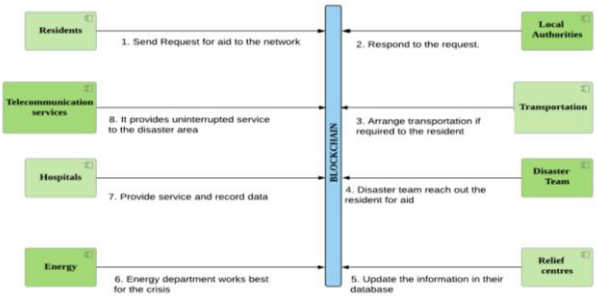

Figure 2 *System Model for Rescue Aid*

User Scenario 3: During Recovery Phase

Information that recorded during disaster response phase will be used for recovery phase. To get to know the total damages and the amount of resources used, blockchain will help to keep track of all the information stored in the blockchain. To provide victim certificate or to release funds for recovery process, blockchain can really provide valuable and accurate information to take strategic decisions. Since, the information stored in the network cannot be tampered, and are transparent, actual status of disaster management process can be known to everyone without any ambiguity. Figure 3 shows the verification of information during the recovery phase.

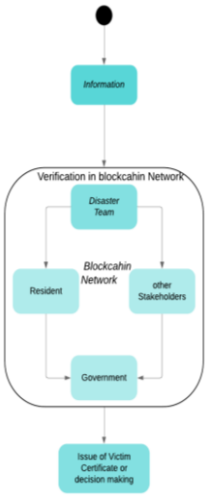

Figure 3 *Verification of Information*

In addition to the above user scanario, there are several other associated problems do occur during and after disaster like: finding nearest relief centre, outrage of disease may spread, interrupted power supply, uneven distribution of water and food, finding missing people, statistical count of affected people and their damages, transportation problem, issuing victim certificates for future welfare, fraudulent behaviour to steal welfare of people etc. Blockchain has the potential to solve all such problem effectively and unambiguously without any delay.

7. Findings of the Study

The study revealed few benefits that involved in the blockchain based disaster management solution. Following are the advantages of the model:

- Technologies used in response and post disaster scenario can be integrated with blockchain so that the recorded information will be made available to all stakeholders connected to blockchain network.By collaborating external datasources or databases to a single platform will provide transparency across the system and the network.
- All the request and response during the disaster were able to addressed in timely manner without any confusion among the members participated in the network.Information passed on to the blockchain network is verified and tampered free hence it is authenticated as a reliable solution.
- All the users in the network are authenticated and no duplication of user exist because of the legitmate processing by the certificate authority in the blockchain network. If any of the user is working maliciously will be quarantined from the

network and no further connectivity will be entertained. The consenses mechanism used in the blockchain network will able to identify the malicious node and thereby no acceptance of information from that respective nodes will be broadcasted.

- Blockchain maintain privacy of the user information by its cryptographic hash function. So there is no fear of threatnening or biased when validating the information in the network. This will improve the authenticity of information and hence right decision can be taken on right time.
- Through blockchain, information can be secured and tampered free. No malicious user can tamper the information as they are connected to merkle root tree. If any changes in any information will change the hash value of the transaction this will not practically feasible to change all the hash value of block till the genesis block. Hence information passed on to blockchain is highly secured.

There are few disadvantages in the model. They are as follows

- Integration of external data or stakeholder can be done with the willingness of their participation in the network. Organizations, individuals or government should show interest towards collaborating to blockchain network. Only if they integrated to single platform, information can be reached to them and consistency can be maintained. Otherwise, people who are not part of the blockchain network will get distorted information and which again complicate the disaster management process.
- Like any technology, there is an open challenge of power supply. If there is any interruption in power supply and the user is unable to use their device to get connected with the people for any request, then the proposed model cannot be used for the respective user during the disaster management activities.
- There is another broad challenge of having awareness about the use of technology. If the user don't have the awareness to use the technology, they find difficult to get connected to the world with reliable information.

8. Conclusions

Blockchain Technology is the underlying distributed network with immutable records enable recent development in various fields. The wide application of Blockchain in few sectors are financial instruments, e-governance, smart property, banking, insurance, supplychain, trade finance, healthcare, power generation and distribution, smart city, fraudulent detection, etc and lot more researches going on in the above area. Beyond, these research area, this paper touches the social cause for the country in the area of disaster management. This paper proposes a complete solution for disaster management which offers to the government for the upliftment of the country's economy by protecting the lives of the people and property damages, through proper planning and control. This model paves way for strategic decision making in terms of monetary and non-monetary plans.

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