Journal of Supply Chain Management System
7 (2) 2018, 1-7
http://publishingindia.com/jscms/

Digital-Information Tracking Framework Using Blockchain

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Abstract

The Internet today uses a new technology called the blockchain, which is based on decentralization communication systems. The blockchain thus leads to the creation of potential system, where we can store data and manage information. This will reduce the role for one of the most important regulatory actors in our society, i.e., middleman.

Blockchain technology evolves by the creation of decentralized currencies. It creates self-executing digital contracts (smart contracts) and intelligent assets, which can have control over the Internet (smart property). Thus, blockchain is considered to be decentralized (autonomous) invention that works with more democratic or participatory decision-making organizations, which operate over a network of computers without any human intervention. This technology can be adopted to any application in the fields of business, finance, networking and law.

The study makes three contributions to theory and practice on blockchain. Firstly, the research clarifies the strategic understanding of blockchain technology by presenting a framework for use in case evaluation and opening the opportunity offered by blockchain to increase trust or negate the need for it in a transaction. Secondly, it presents the assessment of risk by dealing with blockchain transaction and creates a blueprint of security measures towards hybrid framework. Thirdly, it reveals the potential risks and risk-mitigation actions. Finally, it presents list of important applications, bearing the trust in mind the most recent developments.

Keywords: Blockchain Technology, Decentralized, Trust, Risk, Provenance Tracking

Introduction

In this era of technology and innovation, blockchain is the world's leading software platform for digital assets. The blockchain platform is the largest production in the world. It will be using new technology to build a radically better financial system (Kaur, 2015). Blockchain takes care of not only digital assets, but also transactions. Blockchain takes care of all the aspects such as economic, legal, regulatory, and technological challenges. The digital life has begun to run atop a blockchain foundation. The blockchain technology can be used to definite data, information, and digital-information tracking.

Data are raw facts and figures. Data are the very basic pieces of anything. Information refers to the exchange of data and contains some meaning to any organization. Digital information refers to any piece of information, which resides in digital format and includes objects such as images, videos, documents, databases, or processes. Information tracking refers to the practice of tracking web users (and mobile apps users) on the Internet platform, browsing histories, website visitors, trailing email, etc. Thus, blockchain is defined as a distributed database that maintains a shared list of records. The records are in the form of encrypted form, and each encrypted block of code contains the history of every block that came before it with time stamped transaction data down to the second. The chaining those blocks together is called blockchain. Therefore, blockchain technology is defined as a decentralized and distributed digital ledger that is used to record transactions across many computers so that the record cannot be altered retroactively without the alteration of all subsequent blocks and the collusion of the network. Stuart Haber and W. Scott Stornetta described the first work on a cryptographically secured chain of blocks in 1991. The term blockchain 2.0 is an applications of the distributed blockchain database, emerged in 2014. There is a long journey in blockchain and there is lot of

opportunity to work in this field. Blockchain uses the following two primary components:

- Decentralized network facilitating and verifying transactions, and
- The immutable ledger that network maintains all the history of records.

All the members share the transaction ledger in the network, but there is no single point of failure from which records or digital assets can be hacked or corrupted. The records or digital assets are available in multiple copies. Because of the decentralized trust, no one alone or organization is controlling that data. The power of blockchain's distributed-ledger technology can be applied across every kind of digital record and transaction. Blockchain is based on smart contracts where there is no middleman to execute complex business deals, automated exchanges, and legal agreements of data or documents (Czepluch *et al.*, 2015, Roman *et al.*, 2017).

Blockchain enables bilateral settlement by eliminating midpoints failures, delays, collateral cost, and minimizes credit risks and exchange spreads. The advantages of blockchain are no central authority, elimination of intermediaries, real-time settlement, drastic reduction of operational costs, and high level of transparency.

Blockchain technology created the backbone of a new type of Internet. It is originated for the digital currency: bitcoin. It is also called as "digital gold" (Marcella, 2015). The value of currency is increasing every day and has reached to the unexpected heights. The blockchains are made for other types of digital value. Like the Internet (or your car), you do not have to be concerned about how it works. Similarly, we do not need to know how the blockchain works but we should know how to use it. However, having a basic knowledge of this new technology, may companies has come forward to work on those. The companies such as Microsoft and IBM are using their cloud infrastructure to build custom blockchains for customers and experiment with their own use cases, like building a worldwide food safety network of manufacturers and retailers. On the academic side, the researchers are also exploring blockchain applications for projects ranging from digital identity to academic records, medical and insurance records (Wright & Filippi, 2015). The remaining sections of this article are organized as follows. Section 2 introduces the background of blockchain with literature review with respect to trust, risk, security, and provenance. Section 3 describes the research gap analysis with respect to trust, risk, security, and provenance and Section 4 concludes the article.

Literature Review

The origin of blockchain is bitcoin. Blockchain is also called as distributed ledger that uses Bitcoin technology for shared, and synchronizing the digital data. The newly formed blockchains have added with new functionalities to the original one. Bitcoin protocol uses the transaction with a unique cryptographic number and is included with others in a "block" of similar transactions. Every block is "chained" to the next block, using a cryptographic signature ("hash"). This will allow all the blockchains to be used like a ledger, which can be shared and validated by anyone with the appropriate permissions (Pilkington, 2016). As compared to conventional databases, the real novelty of blockchain technology is much more than database. Based upon the set rules, a transaction or business logic is a way to tie to the transaction, it is not at the entire database level, nor the application but only a transaction details.

Challenges to Information Sharing

Digital information is growing faster than ever before. By the year 2020, about 1.7 megabytes of new information will be created every second for every human being on the planet. Sharing information brings both risks and benefits to an organization. It is important that risks associated with sharing information are fully understood and embedded within wider risk-management strategies. With the advent of social media and online technologies, information is freely accessible to all; however, it is important to understand the Lineage of the information before it is used in an organization. As part of the Information Creation and Sharing lifecycle, there are three Key actors in the lifecycle – Producer, Curator, and the Consumer of the Information (Swan, 2015). The increase of digital information has increased the challenges faced by all parties-the Producer, Curator of Information, and the Consumer. Some of the requirements have been summarized in Table 1 as follows:

Table 1: Common Provenance Requirements

Producer	Curator	Consumer
Only trusted user to access Information Get incentives for sharing Secure Audit	Validate lineage to ensure trusted information Get incentives for curation from source	Consumer to verify lineage of information Easy Access to relevant information with minimal intermediaries

The role of Producer is for immutably track provenance of information access including create or update or read or share or delete. Curator secures authentication and authorization mechanism for provenance share. Consumer stores the provenance mechanisms should be decentralization with no central intermediaries.

Quantification of Losses Due to Challenges of Information Sharing

The literature on information sharing in the business press is proliferating. Nevertheless, although the benefits are intuitively clear, the literature is scantily available on the quantification of the benefits as well as the drivers of the magnitudes. There has been some recent interest in quantifying the value of information sharing between manufacturers and retailers. Research based on numerical analysis thus far suggests that the total system benefits a great deal from information sharing. The value of Information Sharing is large. As the amount of Information Sharing is increased, there is an exponential growth seen in the percentage of Cost Savings seen by the Information Consumer (Seebacher & Schüritz, 2017).

Blockchain Key Features

- Transparent Public Lock Box: It is a secure means to transfer money. However, it is not private.
- An asset database that can be shared across multiple sites, geographies, or institutions. However, the blockchain has capabilities far beyond any ordinary asset database because it also includes algorithms that provide a secure mechanism for electronic collaboration that does not rely upon a central authority for the assets to be trusted: The ability of blockchains to execute autonomous scripts that can represent verifiable application logic and help automate a system's rule set.
- A digital ledger in which transactions made in bitcoin or another cryptocurrency are recorded chronologically and publicly: Centralized Location where all transactions are stored so that they can be accessible to all for reconciliation
- The blockchain is a gossip protocol whereby all state modifications to the ledger are broadcast to all participants: There is a significant drag in the ability of all the Global Transactions to be replicated on the Blockchain.

Even though Blockchain started for Financial Transactions, it is now being evaluated as the distributed General Ledger for all applications such as Defense, Medical, IoT, Education and Oil & Gas Sectors. Below diagram is a sample application of Blockchain in the IOT Automotive Industry, where it is used to share information in Peer-to-Peer mode (Kaur, 2015). One of the examples of Blockchain System is self-driven cars where sharing machines. The date are centralized with the individual and devices. Service providers compete to connect trusted peers. Marketplace improvement in terms of sharing the resources and determines fair rate of exchange.

Research Objectives

The information sharing and the blockchain model are the challenges for any industry.

- Information sharing across industries has varying trust or to negate the need for it in a transaction.
- Blockchain model requirement presents the assessment of risk by dealing with blockchain transaction and creating a blueprint of security measures.

The business problem is well taken off with the following details as shown in Table 2 at the end of article.

Table 2: Business Objectives Considered

Business Problem	Theme	Justification	Search Outlook
Need for an Industry Framework for Blockchain Adoption for the Organizations Trust Needs for Sharing Information with Partners	Organization Information Sharing Risks and Barriers	Understand research in Why, Why Not, How and Risks of Information Sharing	Information Sharing, Risks, Benefits, Trust
	Information Sharing	Understand Challenges and Standards for Information Sharing	Lineage Tracking, Trust, Standards
	Blockchain Models for Provenance Tracking or Information Sharing	Understand existing research done on Blockchain Patterns	Blockchain, Information Sharing

Blockchain and distributed databases are differentiated as in basic terms understanding, as distributed databases store information of every transaction in terms of rows and column. Also, it is stored at many servers as per requirements. There is security in terms of user-id and passwords and update regularly to main server by using concurrency management.

Blockchain stores each transaction. The data are stored at each device and concurrency is done through mining. There will be a single copy of document, which is updated and available to all with the updated piece of information. It is identified by certificates generated by device is saved along with the document as defined in Figure 1. A database running on the World Wide Web is most often using a client-server network architecture and is synchronizing with server. A user (client) with permissions associated with their account can change entries that are stored on a centralized server.

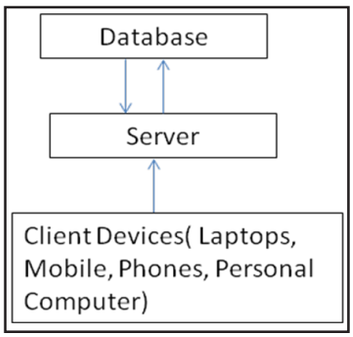

Fig. 1: Client-Server Network Architecture

When the 'master copy' changes, whenever a user accesses a database using their computer, the details will be updated in all the versions of the database entry. The database control of the remains with database administrators, allowing for access and permissions are maintained with a central authority. The concept is not used by blockchain. In the blockchain database, each participant maintains, calculates, and updates new entries into the database. Each of the nodes works together to ensure they are all nodes is providing in-built security for the network defined in Figure 2.

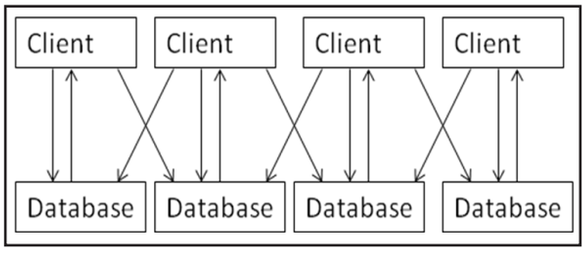

Fig. 2: Decentralized Network Architecture

The consequences of this difference are that blockchains are well suited as a system of record for certain functions, whilst a centralized database is entirely appropriate for other functions (Conoscenti, 2016).

Blockchain Uses

(a) *Decentralized Control:* Blockchains allow different parties that do not trust each other to share information without requiring a central administrator. Transactions are processed by a network of users acting as a consensus mechanism so that everyone is creating the same-shared system of record simultaneously. The value of decentralized control is that it eliminates the risks of centralized control. With a centralized database, anybody with sufficient access to that system can destroy or corrupt the data within. This makes users dependent on the administrators.

(b) *History of Itself:* Most centralized databases keep information that is up-to-date at a particular moment. They more or less are a snapshot of a moment in time. Blockchain databases are not only able to keep information that is relevant now, but also all the information that has come before. Blockchain technology can create databases that have histories of themselves. They grow like ever-expanding archives of their own history whilst also providing a real-time portrait.

(c) *Performance:* Whilst blockchains can be used systems of record and are ideal as transaction platforms, they are considered slow as databases when compared with what is possible for digital transaction technology that we see today with Visa and PayPal.

The way distributed networks are employed in blockchain technology means they do not share and compound processing power, they each independently service the network, then compare the results of their work with the rest of the network until there is a consensus that something happened.

(d) *Confidentiality:* Bitcoin is a write-uncontrolled, read-uncontrolled database. That means anyone can write a new block into the chain, and anyone can read a block in the chain. A permissioned blockchain, like a centralized database, can be

write-controlled and read-controlled. That means the network or the protocol can be set up so only permission participants can write into the database or read the database.

(e) *Distributed-ledger Technology:* A distributed ledger consists of a database spread across multiple sites, regions, or participants. A distributed ledger is required to be decentralized. Otherwise, it would resemble a centralized database, just like the one most companies use today. Distributed-ledger technology is extremely appealing as it removes the intermediary party from the equation.

Moreover, enterprises can use distributed-ledger technology for processing, validating, or authenticating transactions efficiently. Transactional records are stored in the ledger once a majority of the parties achieve consensus. Every recorded transaction is time stamped and has its own cryptographic signature. Moreover, all of the participants in the distributed ledger can view all of the records that are available. This technology helps in providing a verifiable and auditable history of all data that are stored. The primary advantages of distributed ledger are Transparency and Faster Transactions.

- *Transparency:* A distributed ledger gives control of all its information and transactions to the users. In addition, the distributed ledger systems are transparent.
- *Faster Transaction:* Physical markets that are working with digital documentation take a longer time to execute transactions. Distributed ledgers can minimize this transaction time to minutes and are processed 24/7. Distributed ledgers can be used in many businesses such as transportation and energy, potentially saving billions, and facilitating increased back-office efficiency and automation.

Blockchain technology is just one particular type of distributed ledger. Most people know it as the technology originated by bitcoin and other popular crypto-currencies. As the name indicates, it adds blocks to the network chain, which contains transaction records. For enabling chaining of blocks, the blockchain uses a cryptographic signature, known as a hash. These blocks are available for every participant in the network. What differentiates blockchain is that it is much more than just a simple data structure. The two of the primary advantages of a blockchain are Accurate Audit Trail and Easy Asses Exchanges (Crosby *et al.*, 2016).

-Accurate Audit Trail: When you write data to a blockchain, it is etched on the network. This could be used for education credentials or land registries. When you have a series of transactions over time, you gain an accurate and immutable audit trail, which is useful for financial audits.

-Easy Asset Exchanges: Once you have a data stored in a place where no single entity owns or controls it, and no one can change what's already written, this gives you benefits similar to double-entry book-keeping, which means that there are fewer chances of errors.

Distributed ledgers and blockchain technology are those technologies that aim at creating trust by providing visibility and transparency. Moreover, they effectively manage the risks. In coming few years, these technologies can become niche solutions that would allow flexible trust models and consensus processes to provide higher performance (Seebacher & Schüritz, 2017).

Working of Blockchain

The digital ledger keeps the record of all the transaction place on all the peers connected to the peer-to-peer network, The information is recorded in the encrypted format and it cannot be altered without having the keys to open the document. It is used to transfer the currency, record, and contracts. This document is available as decentralized means no single authority is the certifying authority. The encrypted information can be shared across multiple providers without risk. The details are shown in Figure 3.

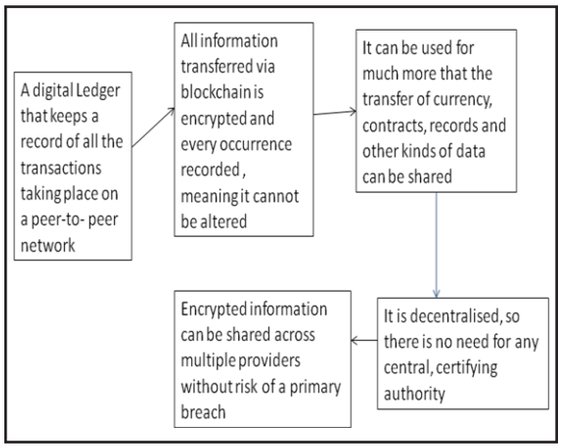

Fig. 3: How Blockchain Works

Suppose Alice wants to send the money to Bob. The transaction is in the form of block. As the block will

be broadcast to all the parties in the network. Once the network approves, the transaction will be valid. The block is added in the chain and money moves from Alice to Bob as shown in Figure 4.

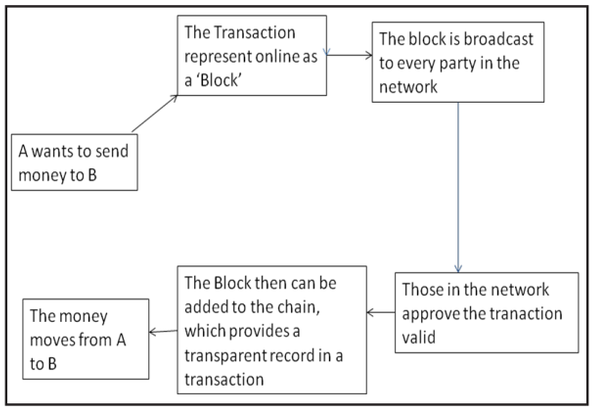

Fig. 4: A Sends Money to B

Research Gap Analysis

Blockchain as a technology is an upcoming technology. It could be that it will not turn out as important as now evangelized. It would be interesting to visit this topic in the future to see how progression has been made and validate the requirements.

Blockchain business models and applications could be one interesting source of information that could be used to test the suggestions put forward. The application framework can be designed by including more areas of applications would give some dimension to findings of this work.

Blockchain technology offers such a model. Blockchains break with many of the flawed assumptions of traditional network security. Together, these properties allow system designers to rethink the fundamental architectures of cyber systems and networks. It should be noted that for the framework concept outlined in this research, there are several gaps are identified as follows:

- There is research in the areas for designing Framework for Blockchain based on specific Use Cases. However, there is no existing research in the area of Blockchain frameworks based on source, needs of an organization defined by the Trust Requirements of Information Sharing

  Blockchain technology is a systemic transaction innovation in information processing. Blockchain enables trust-reliant transactions between parties that were previously unable to trust each other by means of an immutable transaction log in audit trail and verification of order and validity of transactions, among other things. (Rajala, 2016)

- The article does not discuss an integrated view of information security and risk associated with it. Only the provenance ranking will have to be considered.

  Research has identified a set of characteristics that enable trust and decentralization, facilitating the formation and coordination of a service system. Research also provides relevant insights into the influence of blockchain on the industry, and how the impact of trust will significantly influence blockchain applications in the industry (Barnas, 2016). The effectiveness of blockchain is highlighted through this article in the industry of supply chain management. Blockchain decentralization is a key factor that will influence its usage into the industry (Sebastopol, 2015). Blockchain provides multiple benefits to varied users. Based on the industry needs, the user should focus on the available blockchain frameworks available and apply them to their specific needs. (Nachiappan *et al*., 2016)

- This is an important article, which carried out a research on the importance of trust in organizations and its impact on blockchain. However, it does not specifically focus on the area how trust impacts origin of blockchain.

  Blockchain technology is expected to revolutionize the way transactions are performed, thereby affecting a vast variety of potential areas of application. Whilst expectations are high, real-world impact and benefit are still unclear. To be able to assess its impact, the first structured literature review of peer-reviewed articles is conducted. As blockchain technology is cantered on a peer-to-peer network, enabling collaboration between different parties, the service system is chosen as unit analysis to examine its potential contribution. However, it does not specifically focus on the area of provenance and how trust impacts provenance characteristics that enable trust and decentralization, facilitating the formation and coordination of a service system.

  The article provides relevant insights into the influence of blockchain on the industry and how the impact of trust will significantly influence blockchain applications in the industry (Seebacher & Schüritz, 2017).

Conclusion

The blockchain is a disruptive technology with a tremendous transformative potential for our societies. Risks and benefits related to its possible applications, however, must be carefully weighted, avoiding utopian expectations, as well as the pitfalls of technocratic reasoning and determinism.

If properly managed, decentralization of government services through permission blockchains is possible and desirable, because it can increase public administration functionality. Decentralization of governance through open, distributed blockchains like Bitcoin, however, presents serious risks and drawbacks, which offset the benefits.

Although originally designed as disintermediation tools, the ecosystems of fully distributed blockchains are characterized by a great amount of third parties and profitable businesses offering intermediation services, with strong asymmetries of information and power between developers and users. Trend towards centralization, digital divide, lack of transparency in decision-making process, and unaccountable power of core developers – all these factors call into question the egalitarian nature of current distributed networks, making some blockchain advocates' expectations overestimated and unrealistic. In particular, the idea of a blockchain-based authority "floating freely" turns out to be deceptive, since authority is in fact proven to morph into more subtle or hidden centralized forms.

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