Western University

Scholarship@Western

Electrical and Computer Engineering Publications

Electrical and Computer Engineering Department

3-2020

A Blockchain Approach to Social Responsibility

Augusto Bedin
Western University, arodr3@uwo.ca

Wander Queiroz
Western University, wqueiroz@uwo.ca

Miriam A M Capretz
Western University, mcapretz@uwo.ca

London Hydro

A Blockchain Approach to Social Responsibility

Augusto R. C. Bedin[1], Wander Queiroz[1], Miriam Capretz[1], and Syed Mir[2]

[1] Western University, London ON N6A 5B9, Canada
{arodr3,wqueiroz,mcapretz}@uwo.ca
[2] London Hydro, London ON N6A 4H6, Canada
mirs@londonhydro.com

Abstract. As blockchain technology matures, more sophisticated solutions arise regarding complex problems. Blockchain continues to spread towards various niches such as government, IoT, energy, and environmental industries. One often overlooked opportunity for blockchain is the social responsibility sector. Presented in this paper is a permissioned blockchain model that enables enterprises to come together and cooperate to optimize their environmental and societal impacts. This is made possible through a private or permissioned blockchain. Permissioned blockchains are blockchain networks where all the participants are known and trust relationships among them can be fostered more smoothly. An example of what a permissioned blockchain would look like is described in this paper as well as its implementation, achieved using Hyperledger Fabric, which is a business-oriented blockchain framework. This study touches on the benefits available for companies that are willing to engage in socially responsible causes through blockchain. It states in what ways a permissioned blockchain can bring together businesses on common ground to increase their reach and provide better customer service. Finally, a use case is provided to bring to life a real-world situation where blockchain use improves service quality for all the parties involved, both the companies and their customers.

Keywords: Blockchain · Social Responsibility · Hyperledger Fabric · Permissioned Blockchain

1 Introduction

Blockchain is still riding on the hype generated by the cryptocurrency fever after it revolutionized the way that money can be traded, created, and earned. Consequently, blockchain is commonly considered to be a finance-oriented technology because of its inherent traits of security and integrity in handling data. Its prominent and highly regarded success cases Bitcoin and Ethereum are both supporting proofs that blockchain can yield impressive outcomes when and if properly used. The big cryptocurrency blowout led to blockchain technology being introduced into various sectors, evolving and shaping its usage to fit the required purposes. Miraz and Ali [19] point out that blockchain can very well provide in various scenarios other than financial related ones - any circumstance

A. Bedin, W. Queiroz, M. Capretz, S. Mir, A Blockchain Approach to Social Responsibility, DIONE 2020, EAI International Conference on Data and Information in Online Environments, Lecture Notes of the Institute for Computer Sciences, Social Informatics and Telecommunications Engineering book series (LNICST, volume 319)

that would require a high level of trust among parties or even a third party intermediate to validate the interaction can benefit from blockchain's trusted environment. Owing to this, blockchain found its way into energy [4], government [23], IoT [9], and even medical [28] industries demonstrating its flexibility in numerous scenarios.

One of the relatively unexplored paths that blockchain can take is that of social responsibility. It is in the best interest of companies to seek a balance between economic prosperity and societal issues to perform efficiently and effectively. Social responsibility is, as the International Organization for Standardization (ISO) states, the responsibility of an organization for the impacts of its decisions and activities on society and the environment through transparent and ethical behaviour [13]. Social responsibility [20] can be referred to as the ability of a company to focus on issues beyond profitability, extending further than its economic frontiers to touch on ethical, legal, and philanthropic matters. Profit-focused companies are known to dread social responsibilities on the account that it may lead to additional productions costs. Further, Morh *et al.* [20] state that a reliable percentage of customers (49%) are inclined to select a more socially responsible company over its less socially aware competitors, encouraging companies to do so as well as enforcing the relevance of this presented work.

As far as blockchain technology goes, applications with that purpose are still scarce, under development, and far from being thoroughly examined. As a distributed ledger technology (DLT), blockchain technology presents itself as a means to tighten bonds between organizations and its customers by providing more data integrity, security, and transparency for its services. Additionally, permissioned blockchains have a unique knack for handling business activities very well. With a more business-centered attitude, permissioned blockchains enable organizations to structure access levels for its members through valid credentials. When this is achieved, an organization's hierarchical system can be installed on the blockchain to do business through a safeguarded medium. Such a feature, which is only available on permissioned blockchains, can be a useful tool for companies to implement social responsibility. Naturally, it is reasonable to contemplate the likelihood of building such an application without adopting blockchain technologies. Although possible, the technical complexity of it quickly reveals itself a barrier. Blockchain grants, upon majority approval, newcomers a swift integration into the network and so to the data available in it. Security and integrity technicalities are not a matter of contention when dealing with blockchain. Nakamoto's first paper on peer-to-peer network [22], which later became known as blockchain, cites how little effort is required not only to set up a blockchain network but also how easily nodes can join or leave the network at will, accepting that the longest chain of blocks in it as proof of everything that happened when they were absent.

Today's business models are based on catering to potential customers with deals for them so that they can pick the most suitable and highest cost-benefit services they require. This makes sense only from a supply and demand point of view. However, this results in customers scattering their personal information around to various companies, creating a large number of failure points where information can be accessed or viewed by unwanted eyes. One way to minimize this issue would be to gather together, on common ground, companies that operate on the same sector or market into a permissioned blockchain, along with the information of their shared customers. In this manner, customers' information would be available to the organizations through a secure, trusted medium.

Furthermore, businesses might have services that they require from other companies. This would then be reflected in shared customers for these companies. Indirectly related businesses could benefit from tighter interaction. Because in traditional settings the customer must interact with possibly multiple companies to obtain the full service that he or she needs, companies that rely on other companies to perform specific tasks could have a smoother client transition if they were aware of what was happening on each end. As an example, if company A would like company B to perform a service, assuming that both are part of a permissioned blockchain, company A could communicate directly with B, provided that clients' consent was provided, without having the customer acting as an intermediary. This responsibility could be taken out of customers' hands and passed on to the organizations themselves to deal with in favour of improved customer satisfaction. As privacy matters are not to be taken lightly in any circumstance, it is imperative for clients to be aware of where, how and why their information are getting to the companies involved. Avoiding compliance to that would void blockchain's transparencies edge.

This paper sheds light on how blockchain can become a strong ally for wise and socially responsible companies. It specifies how permissioned blockchain networks can be tailored to tackle societal issues that stretch beyond an organization's duty in a way from which they can very well benefit. On this relatively uncharted trail, this discussion elicits how permissioned blockchain, along with its features, can tighten the interaction between common-ground business parties and their shared customers for their benefit and ultimately the benefit of the whole society. This paper's contributions support building a permissioned blockchain environment where organizations can work alongside other organizations to uphold a closer relationship through a candid regime established through smart contracts, direct channels of communications, and transparency due to the nature of distributed ledgers. Its essence is to define how clients can more easily get one organization's services to another as seamlessly as possible.

It is particularly worth mentioning that this paper is limited to the business scenario that it addresses. Its actual contribution acts on strengthening bonds among companies and would be impaired or even ineffective by the lack of business-to-business relationships.

The remainder of this paper is organized as follows: Section 2 addresses blockchain background and the framework that is used to achieve the results, followed by related work in Section 3. The specifics of blockchain design and implementation are outlined in Section 4. Section 5 contains an example of a use case applying the method described in Section 4 and finally, some thoughts and remarks to conclude the paper.

2 Blockchain Technology

The information available in this section formulates the context in which this study is situated. Terminologies and necessary complementary information on blockchain are reviewed to avoid misinterpretation. Additionally, pertinent blockchain and social responsibility studies are also discussed here to support and justify this paper's endeavors.

2.1 Background

Blockchain technology consists of recording the exchange of information within a network where every user holds a ledger with the records of every movement of every piece of information [12]. This information is exchanged in the form of authorized transactions validated by the network users. An arbitrary number of transactions can then be packed along with an identifier (by default, a hash), establishing a block of information. The blocks are created with the sequential identifier of the previous block and put into a chain of blocks. Once the block is placed into the chain, its inner data become immutable and can no longer be tampered with. Because every piece of information inside the blocks has been previously approved by the majority of users in the network, the data are regarded as legitimate and trustworthy. This process is depicted in Figure 1.

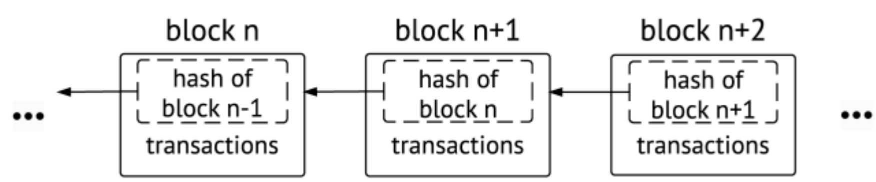

Fig. 1. Blockchain: each block contains an identifier hash pointing to the previous block and a package of transactions that have taken place in the network. [6]

Figure 1 illustrates the primary blockchain *modus operandi*. The technology is flexible enough to be tailored to handle the desired information that is relevant to its users. In other words, the ledgers on every user's node will contain information that is pertinent to the whole body of users.

- **Permissionless Blockchain -** The scenario depicted above holds for permissionless, public blockchains. Public blockchain networks allow virtually anyone to join, participate, and access the information within them. Granted, this type of blockchain is presumably large in scale, and therefore to control its anonymous and untrusted nodes, a consensus must be reached either through the approval of a majority of users or through a Proof of Work

(PoW) [5]. The PoW is evidence that a user has spent enough computational effort to validate its transaction.

– **Permissioned blockchain -** Private, permissioned blockchains are generally smaller in scale. In permissioned blockchains, to join, one must hold a valid certificate issued by an accredited entity in the network. This normally means that an administrator node must assign an identity for newcomers so that they are no longer anonymous, and other users/nodes can recognize their actions on the blockchain. Permissioned blockchains act as a semi-trusted setting [5], and because of that, consensus can be reached differently than on permissionless, public blockchains. Consensus on permissioned settings is not as costly to achieve as on permissionless blockchains since nodes are identifiable and trusted within that network. No proof of work is required for the nodes to invoke transactions. The only necessary verification is the validity of the data within a node's transaction.

– **Smart contracts -** Smart contracts are, in a blockchain frame of reference, code scripts stored within the blockchain [6]. They are triggered autonomously and fundamentally by transactions in a structured way throughout all the nodes in the network, conforming to the data used by the triggering transaction. Figure 2 illustrates how a smart contract execution process works. When invoking a transaction that triggers a smart contract its code will run in every node involved in the transaction, executing the business logic that it was designated for. Smart contracts enable a more fluid work flow by prompting computational procedures on demand, responding involved parties under a structured policy. By doing so, they allow a reduced number of trusted intermediaries to be involved in parties' transactions while also minimizing accidental and erroneous transactions.

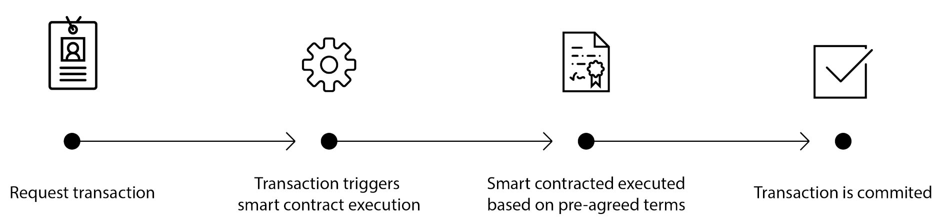

Fig. 2. How smart contracts are triggered and executed on a valid transaction.

2.2 Hyperledger Fabric framework

The results obtained and described in this paper were achieved using Hyperledger Fabric [11]. Hyperledger Fabric is an open-source permissioned blockchain framework that has been promoted by the Linux Foundation [3] since 2015, and that is fine-tuned with business needs in mind. Hyperledger Fabric, when compared to Ethereum [2] and Corda [1], which are the most known and used blockchains for private purposes, stands out for its scalability [27], flexibility, and customization properties [26]. It is structured to enable high levels of transparency among its users, reinforcing the trust relationship among them. Moreover, because each enterprise on the network holds its ledger, information can be quickly shared and accessed by every participant.

On Fabric, each participant must hold an official identity issued by a trusted Membership Service Provider (MSP) within the network. Having an identity means that the user holds a valid certificate to operate within the blockchain. Having an MSP from an organization in the network to endorse its employees is what differentiates Hyperledger Fabric from other blockchain frameworks. For instance, if organization X has an MSP to issue identities on the network, *X's* employees can be issued a valid certificate to operate within the network. This enables companies to have a reliable communication channel as well as to log their actions in a transparent and secure environment. When an organization joins a Fabric network, it is called a participant [11]. From now on, the term *participant* will be used to describe an authoritative entity within a Hyperledger Fabric blockchain.

Besides, Fabric allows private and public communication routes to be instituted for participants to converse without sacrificing the proper ordering of network activities, avoiding disparities in a transaction and block timelines. Nodes can be categorized as peer nodes and orderer nodes. Peers generally hold ledgers of information and can request transactions. Peers are the ones who must hold a valid MSP certificate to perform actions on the network. Orderers are nodes that are in charge of adequately ordering transactions in a timely manner, as well as ordering the generated blocks that hold them. Because they cannot request any transactions, they do not require identities to be on the network.

Note that in Fabric smart contracts are called *chaincodes* [11]. From this point on, smart contracts will be referred to as chaincode.

The block generation process on Fabric is slightly different from other frameworks. These differences are highlighted in its block generation process, which is composed of three phases: proposal, ordering and packing, and validation and commit, as depicted in Figure 3.

1. In the first phase (proposal), an application or participant requests authorization to invoke chaincode from the respective endorsing peers in the network to check whether they agree with the outcome of this chaincode. If they do, they send a response back with their digital signature approving the request. If a majority of the endorsing peers do not sanction it, the request gets rejected.
2. Ordering and packing rely on packaging the approved transactions into blocks, a task that is performed by the ordering node. Ordering nodes do not execute any chaincode and are specially designed to order the blocks properly in the blockchain. The transactions are not always ordered in the same sequence that they are received by the ordering node because multiple

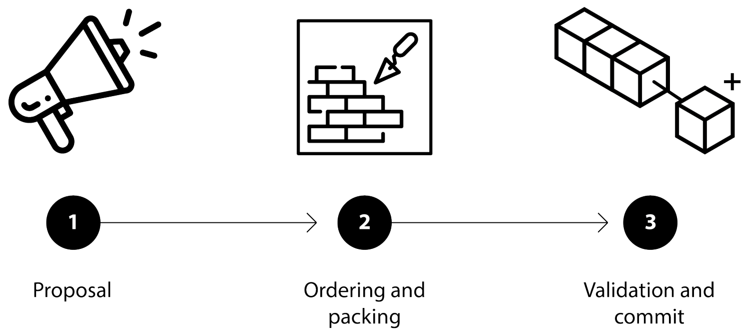

Fig. 3. Simplified visualization of the process described in subsection 2.2. **1** - The proposal phase notifies the concerning peers of its intent. **2** - The ordering and packing phase is responsible for correctly building the block to be added to the chain. **3** - The validation and commit phase checks if the block's information checks out and if so, adds it to the blockchain.

ordering nodes can receive transactions simultaneously. However, it is worth mentioning that the ordering nodes follow a systematic procedure to pack the transactions into blocks. Once the packing of a transaction into a block is done, it is definitive. In Fabric, its position in the chain is irrefutably assured at this point, which is not always true for other blockchain frameworks because some other frameworks may require additional transaction validation after a transaction has been inserted into a block. Fabric assumes that the transactions within a block are absolute because they were previously endorsed by the majority of the network's peers.

3. For validation and commit (the final phase), the blocks are disseminated to other connected peers, and each of them processes the received block to maintain consistency. Once a peer secures a block, it then verifies all the transactions within it before committing them to its ledger to ensure that none of them has been invalidated midway. This may occur because the transaction might have already been entered into the ledger, and therefore adding it again would result in an inconsistency fault. Once everything has been checked, the ledger is updated with a new block of transactions, keeping invalid transactions for audit purposes. The addition of a new block in the blockchain triggers an event to summarize the newly added information to all the peers. Events are also an indicator that block addition processes have been performed. The blocks are organized in the same way as depicted in Figure 1.

Ultimately, the information stored in blocks and moved around through transactions within Fabric is called an *asset*. An asset is an information that the network users perceive as valuable. It is the main focus of the network to exchange that information and to make it available on all the ledgers for users to access, as illustrated in Figure 4.

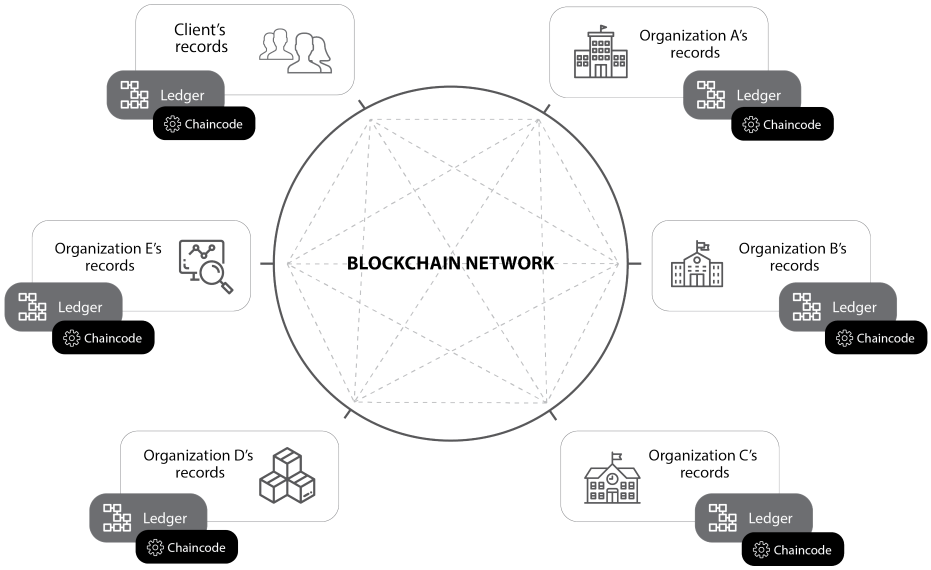

Fig. 4. Organizations and customers join a blockchain to have access to a shared ledger of information. Each participant is a valid peer that holds a copy of the shared ledger. Also, each participant can execute its designated chaincode to perform actions on the network.

Another concern addressed in Hyperledger Fabric is the time complexity of its performance. Blockchain technology inherently sacrifices its read and transaction times for security. Latency on transaction and read times can often take seconds or even minutes on traditional permissionless blockchains. To avoid that, Hyperledger Fabric stores its world state (the most recent state of every node) on a quickly accessible nested database on every node. This cuts the reading time significantly over the fact that searching for information within the ledgers does not require a linear search down the chain of blocks. Of course, many things should be taken into consideration when evaluating a blockchain operation's time complexity such as the number of nodes, the geographical distribution of nodes, type of data stored, workload, among others described in the Hyperledger Performance and Scale Working Group's whitepaper [24]. Overall, time complexity varies from use case to use case, and an ideal equation has not been determined yet, but a suitable suggestion is to use $Product = TransactionThroughput * log(NetworkSize)$.

3 Related work

Blockchain for enterprises is significantly on the rise. This is confirmed by the quantity of papers on the topic published in recent years as different applications using blockchain are revealed. Hebert and Di Cerbo [10] outline a methodology for businesses to better reap the benefits of using blockchain in the private sector. It expresses the concerns and advantages of using blockchain while drawing attention to how to mold software architectures to achieve maximum business blockchain efficiency. Various markets, financial and non-financial, have become aware of blockchain benefits, and its implementation has spread to seize new-found opportunities [8].

Addressing healthcare, Liang *et al.* [17] highlighted how permissioned blockchains have presented themselves as a strong ally in dealing with healthcare issues, given their enhanced data security and integrity. Due to the sensitivity and privacy requirements of health data, blockchain has become a powerful tool for safely collaborating and sharing data in this category.

In terms of financial and business data, Chua *et al.* [7] have presented a solid example of how permissioned blockchains, specifically Hyperledger Fabric, can serve as a foundation for business activities. It explains how a group of closely collaborative enterprises can gain quick access to data on a distributed ledger network such as a blockchain. In addition, the study stresses how permissioned blockchains provide access control over their data to enable precise interoperability among the network's participants.

Expanding on permissioned blockchain applications, Kirillov *et al.* [14] make a case for Hyperledger Fabric usage for government purposes, in particular for e-voting. They propose an e-voting blockchain model to increase trust among network participants. Again, the handling of sensitive data such as government information demands a secure and reliable environment, one that blockchain can easily provide.

The examples portrayed above are just a few examples of environments where a permissioned blockchain could be helpful. As stated previously, social responsibility-focussed blockchain applications are still scarce. Use of a blockchain in support of a social cause was examined in Liu *et al.* [18], where a blockchain was used to store carbon footprint emissions in Taiwan. The immutability and irreversibility of blockchain data provide a reliable window to check a company's carbon emissions, encouraging more compliant behavior towards environmental regulations and hence towards society overall.

As blockchain applications mature, more complex scenarios can be tackled. On such trend, Li [16] focuses on a philanthropic logistics platform that takes advantage of blockchain's high-profile transparency and credibility. Using Ethereum, the study focused on implementing an application geared towards social welfare maximization, a pertinent example of a social responsibility-targeted blockchain.

Lastly, blockchain geared towards social responsibility is continuously increasing its popularity given social awareness growth in society as general. Mukkamala *et al.*'s study [21] outlines several opportunities and applications for blockchain to enhance social business models in pursuit of maximizing its societal impacts as well as their profits. United Nations Research Institute for Social Development's (UNRISD) working paper [25] highlights blockchain's potential for creating co-operation at scale with cooperative structures for financial inclusion. Kouhizadeh and Sarkis study [15] discuss how blockchain can help supply chains to be more green, reducing waste and thus being more socially aware by providing insights and use cases on the subject.

4 Social responsibility

Although an organization can strive for social responsibility in many ways, this section discusses how this can be accomplished through permissioned blockchain networks. A use case is also described to clarify how this can be implemented in a real-world setting.

4.1 Design

With the framework that Hyperledger Fabric provides, it is possible to come up with a blockchain design that can reap the advantages of a permissioned blockchain to achieve social responsibility objectives.

Fabric enables straightforward translation of this scenario into a blockchain. In a simplistic approach, companies with that goal in mind can create and join a permissioned blockchain incorporating an MSP within it, turning them into participants. From there, their main asset on the network would be their standard customer information and what kind of service they can provide or require from one another that jointly affects these customers. Transactions and chaincode can be implemented to automate workflow and minimize delays previously experienced when using less efficient communication routes.

Permissioned blockchain networks, and especially Fabric, are conveniently extensible and can accommodate numerous nodes with little effort. Integrating new companies is not only possible but highly encouraged because businesses joining the network can make themselves noticed by existing customers, who are prone to trust newcomers because access to the blockchain is controlled.

It should be pointed out that cooperating with other businesses is not one of the responsibilities of companies. Essentially, the goal is to set up an environment where companies can work actively together for the benefit of their customers. Businesses have the opportunity to help each other grow and profit mutually while increasing customer satisfaction.

Figure 5 presents an example of how a network arrangement can facilitate communication between organizations. Organization A, Organization B, and customers[3] are inserted into a permissioned blockchain network. A customer requests a service from Organization A. Before the service can be delivered, a service from Organization B is required. In traditional settings, Organization A would advise the client to obtain the service from Organization B first and then return to obtain the initially requested service from Organization A, as illustrated in Figure 5.a. This situation can drastically change when a permissioned

[3] Each customer is represented in the blockchain by a single node, meaning that every customer's action in the blockchain network is validated through a single certificate held by the customer node.

blockchain network is used. Within a blockchain, Organization A can promptly communicate with Organization B to obtain the prerequisite service without having the client as an intermediary. The client can then receive the service that he/she initially requested without the hassle of interacting with both companies back and forth, as shown in Figure 5.b.

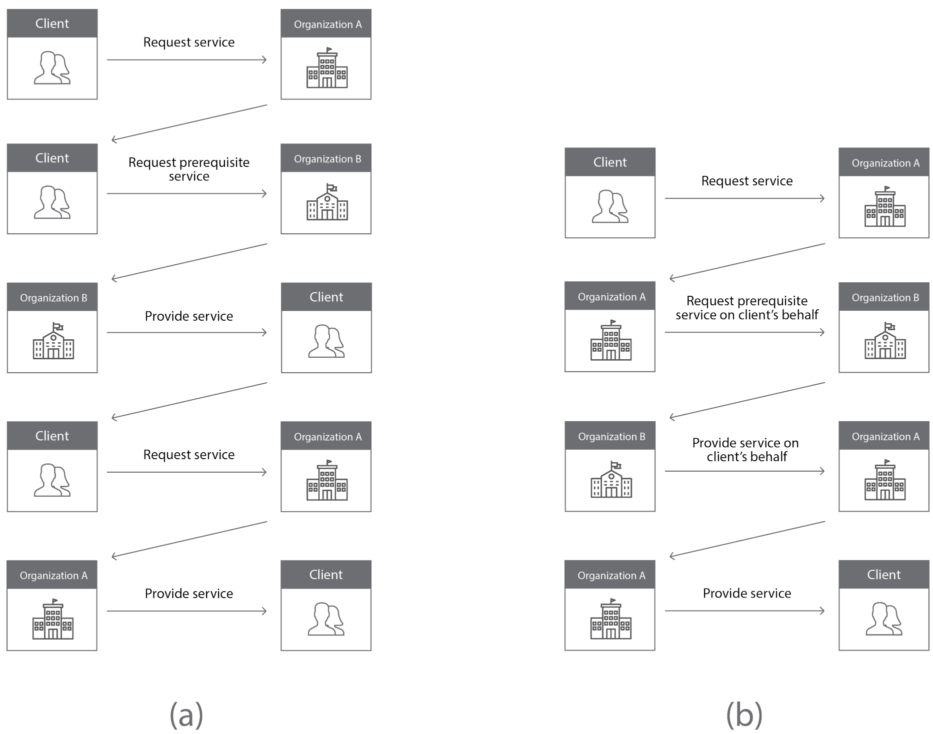

Fig. 5. Comparison of service delivery in a traditional setting (a) and through a permissioned blockchain (b).

.

4.2 Use case

Section 4.1 described how a permissioned blockchain can bridge the gap between companies and enable them to interact, putting the responsibility of providing a complete service in their hands instead of having the customer chase after it. In this section, a real business situation is depicted to clarify the merits of a permissioned blockchain over traditional approaches.

For the sake of context, assume now that Organization A is a town's local energy provider and that the customers are households that benefit from the provider's service. For numerous reasons, there might be a time where a household is unable to pay its electricity bills, forcing Organization A to perform a service interruption. Between the time of late bill detection and the actual disruption, customers have a grace period to look for assistance programs that can support them. Therefore, it becomes the customer's responsibility to look for help to avoid being disconnected because energy providers and assistance programs work separately. Such a scenario not only puts the customer in danger of being disconnected but also the energy provider in danger of not receiving any payment and the assistance programs in risk of being considered ineffective, turning this into a no-win situation.

In a permissioned blockchain network composed of a local energy provider (Organization A), its customers, and finally an assistance program (Organization B), helping customers in need morphs into a much simpler process. With direct routes of communication, the local energy provider can inform assistance programs directly which customers require aid. Given the distributed ledger nature of blockchains, assistance programs within the network may have access to the local energy provider's list of clients, effortlessly identifying which customers need help. Permissioned blockchains can incorporate organizations smoothly, making it easy for multiple assistance programs to take part in the network and cooperate with the local energy provider and its customers.

The stronger alliance built among entities within the blockchain network and the availability of information are already compelling reasons to use blockchain in situations like that just described. On top of that, using chaincode to automate the matching of a customer in need with the best-fitting eligible assistance program for their case makes the use of permissioned blockchains more persuasive. Once a customer's status shifts to being behind on their bills, chaincode can inform him/her of assistance programs for which they are eligible, enabling them to pick the most suitable one for them. Furthermore, aside from blockchain helping clients better avoid disconnection, it can also produce a promising environment for assistance programs to achieve a broader radius of effectiveness, as well as enhancing the local energy provider's payment collection efficiency. In summary, the full outcome can bring about a win-win situation for all parties involved.

The premise of this use case is to fit the application in a real-world situation with feedback from the company, which would implement it as well as reap its benefits, consolidating its validity as a socially responsible use for blockchain.

5 Conclusions

Blockchain is a multifaceted tool that can be adapted to fit a great variety of purposes. Although most blockchain applications emphasize cryptocurrency and related financial technology, a plethora of other sectors remain fairly untouched by it. There is no reason to believe that organizations that work closely together would not benefit from operating within a permissioned blockchain setting provided that the transparency and security traits of blockchain can profoundly and positively impact the trust relationship between them.

This study has focussed on demonstrating how companies can build social responsibility by taking on, through blockchain, some of their customers' burden of dealing with several companies at a time to receive a single service. By identifying the needs of their customers, companies can limit their downtime by directly reaching the company that provides the service on which the customer depends, instead of having clients as intermediaries. This feature is an extraordinary service that goes beyond the reach of a company's responsibility, but it is also one that can be quite rewarding in terms of both financial profit and reputation.

Also presented here were a structured approach and a real-world scenario illustrating the use of a permissioned blockchain to seize an opportunity to help customers stay up to date with their electricity bills and avoid disconnections. It highlights how working together with recognizable parties is paramount to provide better services to those in need. However, businesses are often reluctant to cooperate because disclosing operational information can be seen as a threat rather than an opportunity for growth. This paper aims to foster the idea of using blockchain as a means to securely unveil information with other companies to mature and progress together. The benefits described here are expected to lead to a more socially wise way of doing business.

Because a permissioned blockchain can centralize customer information, it can become a single means of access to these data. By turning blockchain into an inviting and promising environment for businesses, in terms of future work, it is possible to consolidate a consortium of companies to serve its customers better. Elaborating on this with a real-world scenario, it is possible to gather together companies that provide basic needs such as energy, gas, water, telecommunications, and TV services into a permissioned blockchain to offer their services to households more swiftly (assuming, of course, that the households' information is stored in the blockchain as customer data). On top of that, assistance programs relating to the most essential services such as electricity, water, and gas can be added to the consortium to guarantee service delivery to households in need of aid. Taking advantage of Hyperledger Fabric's ability to enable exclusive routes of communication between the participants in a blockchain, an organized conversation among assistance providers and service providers can be achieved without disrupting other participants. This feature enables a blockchain to manage an increasing number of participants in the network without creating interference.

Given all the customer's data transfer and exchange, privacy, and legal implications, concerns do arise. This scenario is based entirely on customers' consent, willing to allow their information to travel among service providers for their benefit and interest. Indeed, further legal ramifications must be inspected upon the actual implementation of the blockchain network.

With this in mind, one further step in this study would be to explore the possibilities of bringing together multiple business partners into a single blockchain so that customers can make use of a single service request platform. The information that each partner would require from its customers would be elicited to design and develop the appropriate smart contracts that address their needs.

6 Acknowledgement

This research has been partially supported by an OCE VIP II at Western University (VIP II - 31101). The authors would like to thank London Hydro for supplying industry knowledge used in this study.

References

1. Corda. https://www.corda.net/, accessed: 2019-01-13
2. Ethereum. https://www.ethereum.org/, accessed: 2019-01-13
3. Linux Foundation. https://www.linuxfoundation.org/, accessed: 2019-01-13
4. Andoni, M., Robu, V., Flynn, D., Abram, S., Geach, D., Jenkins, D., McCallum, P., Peacock, A.: Blockchain technology in the energy sector: A systematic review of challenges and opportunities. Renewable and Sustainable Energy Reviews **100**, 143–174 (2019)
5. Baliga, A.: Understanding blockchain consensus models (2017)
6. Christidis, K., Devetsikiotis, M.: Blockchains and smart contracts for the internet of things. Ieee Access **4**, 2292–2303 (2016)
7. Chua, P.H.T., Li, Y., He, W.: Adopting hyperledger fabric blockchain for epcglobal network. In: 2019 IEEE International Conference on RFID (RFID). pp. 1–8. IEEE (2019)
8. Crosby, M., Pattanayak, P., Verma, S., Kalyanaraman, V., et al.: Blockchain technology: Beyond bitcoin. Applied Innovation **2**(6-10), 71 (2016)
9. Dorri, A., Kanhere, S.S., Jurdak, R., Gauravaram, P.: Blockchain for iot security and privacy: The case study of a smart home. In: 2017 IEEE international conference on pervasive computing and communications workshops (PerCom workshops). pp. 618–623. IEEE (2017)
10. Hebert, C., Di Cerbo, F.: Secure blockchain in the enterprise: A methodology. Pervasive and Mobile Computing p. 101038 (2019)
11. Hyperledger: Hyperledger fabric documentation, release 1.4 (2019), available at: https://hyperledger-fabric.readthedocs.io/en/release-1.4/
12. Iansiti, M., Lakhani, K.R.: The truth about blockchain. Harvard Business Review **95**(1), 118–127 (2017)
13. Guidance on social responsibility. Standard, International Organization for Standardization (Mar 2010-11)
14. Kirillov, D., Korkhov, V., Petrunin, V., Makarov, M., Khamitov, I.M., Dostov, V.: Implementation of an e-voting scheme using hyperledger fabric permissioned blockchain. In: International Conference on Computational Science and Its Applications. pp. 509–521. Springer (2019)
15. Kouhizadeh, M., Sarkis, J.: Blockchain practices, potentials, and perspectives in greening supply chains. Sustainability **10**(10), 3652 (2018)
16. Li, J.: Public philanthropy logistics platform based on blockchain technology for social welfare maximization. In: 2018 8th International Conference on Logistics, Informatics and Service Sciences (LISS). IEEE (2018)

17. Liang, X., Zhao, J., Shetty, S., Liu, J., Li, D.: Integrating blockchain for data sharing and collaboration in mobile healthcare applications. In: 2017 IEEE 28th Annual International Symposium on Personal, Indoor, and Mobile Radio Communications (PIMRC). pp. 1–5. IEEE (2017)
18. Liu, K.H., Chang, S.F., Huang, W.H., Lu, I.C.: The framework of the integration of carbon footprint and blockchain: Using blockchain as a carbon emission management tool. In: Technologies and Eco-innovation towards Sustainability I, pp. 15–22. Springer (2019)
19. Miraz, M.H., Ali, M.: Applications of blockchain technology beyond cryptocurrency. arXiv preprint arXiv:1801.03528 (2018)
20. Mohr, L.A., Webb, D.J., Harris, K.E.: Do consumers expect companies to be socially responsible? the impact of corporate social responsibility on buying behavior. Journal of Consumer affairs **35**(1), 45–72 (2001)
21. Mukkamala, R.R., Vatrapu, R., Ray, P.K., Sengupta, G., Halder, S.: Blockchain for social business: Principles and applications. IEEE Engineering Management Review **46**(4), 94–99 (2018)
22. Nakamoto, S.: Bitcoin: A peer-to-peer electronic cash system. Tech. rep., Manubot (2019)
23. Ølnes, S., Ubacht, J., Janssen, M.: Blockchain in government: Benefits and implications of distributed ledger technology for information sharing (2017)
24. Performance, H., Group, S.W.: Hyperledger blockchain performance metrics (2018)
25. Scott, B.: How can cryptocurrency and blockchain technology play a role in building social and solidarity finance? Tech. rep., UNRISD Working Paper (2016)
26. Valenta, M., Sandner, P.: Comparison of ethereum, hyperledger fabric and corda. [ebook] Frankfurt School, Blockchain Center (2017)
27. Vukolić, M.: Hyperledger fabric: towards scalable blockchain for business. Trust in Digital Life (2016)
28. Xia, Q., Sifah, E.B., Asamoah, K.O., Gao, J., Du, X., Guizani, M.: Medshare: Trust-less medical data sharing among cloud service providers via blockchain. IEEE Access **5**, 14757–14767 (2017)