Potentials of Blockchain Technology for Payroll Systems

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ABSTRACT
Blockchain technology has the potential to prevent fraud and increase effectiveness of payroll systems. Payroll management is an essential and critical process for every government, businesses and other organizations as it ensures accurate and timely payment of staff. Payroll systems face challenges in the developing countries such as lack of decentralization, ghost workers, cybercrimes and other manipulations done by people. This paper examines the problems of payroll systems in developing countries and how the capabilities of blockchain can be harnessed to resolve them. The remainder the paper shows how blockchain technologies are a promising approach to mitigating challenges associated with the payroll systems. Through analysis of existing literature we explain the relevance of blockchain technology in general and its usefulness for payroll systems.

Keywords
Blockchain, Permissioned Blockchain, Payroll, Decentralization, Public Universities

INTRODUCTION

Payroll management is an essential and critical process for every government, businesses and other organizations as it has effects on payment of staff, which should be accurate and timely (M. Singh et al., 2017). Financial manipulation and frauds became common in organizations when their payroll system's internal control is vulnerable (Brant et al., 2019). Brant et al., (2019) also suggest that control and security of electronic payment systems should be given top priority. According to Wait (2016) today's digital world, many payroll-related issues are reported daily. Ministry of Business Innovation and Employment (MBIE) in New Zealand reported that over 24 thousand workers are underpaid. Even though investigation is yet to be completed, there are speculations that two million additional staff may be affected (Wait, 2016). Payment platforms in developing countries also face challenges including centralization, ghost workers, cybercrime and manipulation.

As a case study, the Nigerian government is presently using the Integrated Payroll and Personnel Information System (IPPIS) as a payroll platform to pay its workers (Uzoh, 2020). The platform has grave defects and lots of anomalies (Aluko, 2020). IPPIS violates university autonomy by simply denying Universities the privilege to recruit their own staff. Employment is completely shifted from Universities to the Office of the Accountant General of the Federation (AGF), this gesture gave rise to Ghost Workers and lots of abnormalities (Uzoh, 2020). IPPIS also suffers from underpayments, overpayments, omissions, and payment to dead and retired lecturers. A ghost worker is someone who is included fraudulently on a government or company's payroll but does not do any work. Ghost worker can also be a real person who has died or resigned from the company, but their data remains intact and active for the benefit of other persons.

In the same vein, another developing African country, Ghana, is battling with their payroll system. According to (Quarm et al., 2020) the current platform is incapable of identifying and detecting ghost workers. Their government is unable to estimate losses due to the weakness of the payroll system.

Similarly, in Democratic Republic of Congo (DRC), the payroll system the government is using has issues of decentralization. According to (Moshonas, 2018), the payroll department merely validate the payroll commitments supplied by the Line Ministries. That led to omissions on the listings, fraudulent inclusion, ghost workers, embezzlements, and others.

In Tanzania's public universities, Masele & Kagoma (2021) reported that there is a great failure with their payroll system with delayed payment and poor accountability. There were 19,700 cases of ghost workers and exaggerated wage bills. This shows that the Human Capital Management Information System (HCMIS) is not ensuring data integrity and accountability.

The remainder of this paper shows how blockchain technologies are a promising approach to mitigating challenges associated with the payroll systems in the developing countries as described above, such as lack of decentralization, ghost workers, cybercrimes and other manipulations done by people. Through analysis of existing literature we explain the relevance of blockchain technology in general and its usefulness for payroll systems.

Then we draw on relevant examples of existing blockchain technology applications to show how blockchain features like decentralization, security, transparency and accessibility has resolved several limitations, the study also exhibits how permissioned blockchain in particular has many useful properties. We then discuss how these blockchain technologies could be used effectively in payroll systems to reduce many of the challenges described previously.

BLOCKCHAIN TECHNOLOGY

Sikorski et al., (2017) defined Blockchain as a distributed electronic database which is decentralized and capable of storing records, events and transactions and set rules on how this information is updated. It allows transacting parties to exchange ownership of digitally represented assets in a real-time and immutable peer-to-peer system without the use of intermediaries. The figure below illustrates the six steps of asset exchange between two economic actors using blockchain technology.

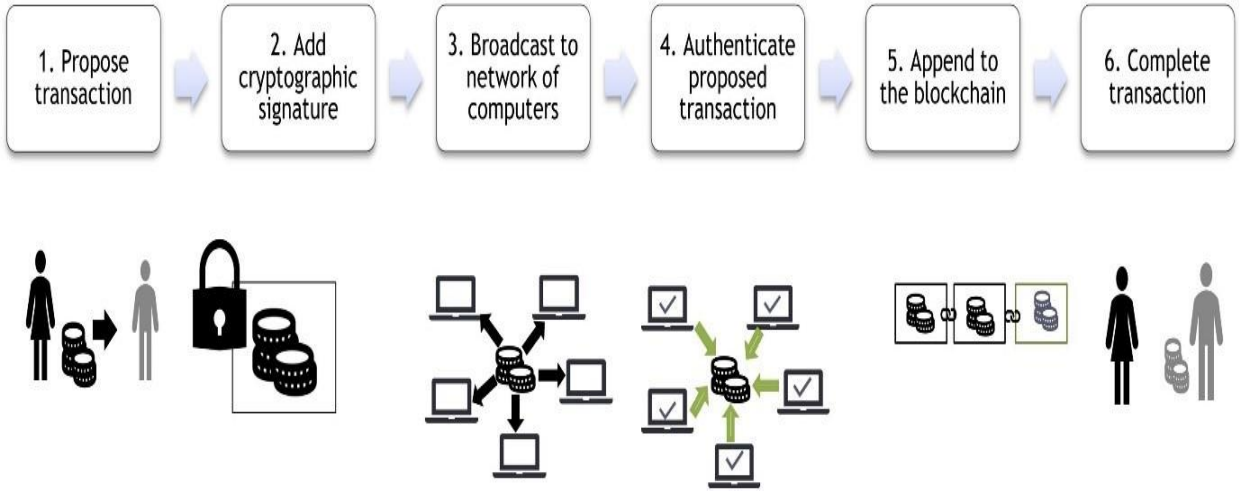

Figure 1. Source: Adapted from (Morkunas et al., 2019)

Normally, digital records were kept and managed through centralized systems. Today, blockchain technologies enable a robust means to manage records in distributed federated systems. The technology can revolutionize record-keeping of financial transactions (Abadi & Brunnermeier, 2018). Baker & Werbach (2019) suggest that governments' financial systems would benefit from blockchain technology because the finance sector's core function of verifying and transferring financial information is closely aligned with blockchain's core function. Smits & Hulstijn (2020) says it is essential that the potential of blockchain for business applications be understood. (Batubara et al., 2018) state that the potential of blockchain have been investigated and yet there is no clear guidance on whether blockchain is an appropriate technology for e-government. Moreover, (Yaga et al., 2018) suggest that blockchain should be investigated with the view of "how could blockchain technology potentially benefit us?" instead of "how can we make our problem fit into the blockchain technology paradigm?". Governments should regard the technology as a new technological solution and use it in appropriate scenarios and situations.
Blockchain has attracted a lot of attention but there is still limited interest in adopting the technology (Batubara et al., 2018). However, (Carter & Ubacht, 2018) argued that the reason the technology is not yet accepted is because of the lack of case studies in literature that should show its potential. It is therefore difficult for governments to adopt a technology with known technical limitations and unknown benefits. A substantial number of banks in advanced countries are already investigating the potentials of blockchain technology (Baker & Werbach, 2019). Many other solutions have been presented to tackle the dynamic security requirements of systems and one of such solution is the blockchain (Parizi et al., 2020).

RELEVANT BLOCKCHAIN APPLICATIONS

Today, blockchain applications have moved far beyond cryptocurrency and bitcoin. The technology is impacting a variety of sectors due to its transparency and fairness. Below are some of its recent applications.

(Kuhn et al., 2021) developed a decentralized blockchain application and called TokenTrail. It focuses on traceability requirements of multi-hierarchical assembly structure. The architecture was based on consortium Ethereum network which ensures trusted and shared database within an economic processing framework. The framework addresses risks identified for conventional systems as well as cost and data risks which arise from interference of intermediaries.
However, the solution has certain limitations, tradeoffs between data protection and sufficient transparency can be exposed. Traceability data may contain intellectual property data as well. The authors suggested further measures of data protection should be added on proposed solution as future studies. This may be done by encrypting the data entries from the onset.
Antwi et al. (2021) created testing scenarios using Hyperledger Fabric to study different use cases for healthcare applications. They confirmed that the evaluation reveals promising benefits of private blockchain. The study defined key criteria for implementation of secure blockchain-based healthcare applications. Two limitations of the study are that it does not evaluate performance parameters and the test was run on Hyperledger fabric only. They stated that in future work, Hyperledger Explorer tool should be used to explore consensus, peers, blocks and energy consumption.
Lyu et al. (2020) designed and proposed a Secure Blockchain-based Access Control (SBAC) framework context provider having the ability of sharing, audit and revocation on its content in a secure way. The authors designed a matching-based access control model to achieve hierarchical access as well as to present a blockchain-based access token to overcome single point of failure and balance privacy and audit.

Public, Private, Permissionless and Permissioned Blockchain

Lin and Liao 2019 categorized blockchain into three segments based on data accessibility

i. Public Blockchain: this is an open type of blockchain where everyone can join and participate in transactions and consensus process. Peers in this category can check transactions and verify them.

ii. Private Blockchain: In this type of blockchain, there is strict authority management on data access. Only one organization or sub-organizations within same organisations are allowed to read and write data.

iii. Consortium Blockchain: this is where groups of organizations form a consortium are permitted to submit, read and write transactional data.

On the other hand, on the need of authorization and participation, there are permissionless and permissioned blockchain, according to Wüst & Gervais, (2018).

i. Permissionless Blockchains: according to are open and decentralized. Any peer can join and leave the network as reader and writer at any time. There is no central entity which manages the membership, or which could ban illegitimate readers or writers. This openness implies that the written content is readable by any peer.

ii. Permissioned Blockchains: this only authorize a limited set of readers and writers and a central entity decides and attributes the right to individual peers to participate in the write or read operations of the blockchain. To provide encapsulation and privacy, reader and writer could also run in separated parallel blockchains that are interconnected.

Smart Contract

According to Khan et al. (2021) Smart Contracts are executable codes which run on blockchain to process and execute agreement between untrustworthy parties. Smart Contract is aimed to transform paper contracts to digital contracts (A. Singh et al., 2020). A Smart Contract can be termed as a developed script when triggered by a blockchain transaction, predefine actions are executed. Smart Contracts decreases trust issues between parties involved (Ante, 2021). Smart contracts are software scripts similar to other scripts that run on non-blockchain platforms.

Permissioned Blockchain in Payroll

Blockchain technology was first used for a public network that does not require central control, but private and permissioned systems are becoming popular Polge et al. (2021) and are more appropriate for payroll systems. Wüst & Gervais (2018) viewed permissioned blockchain as "To only authorize a limited set of readers and writers, so called-permissioned blockchains have been recently proposed. Here, a central entity decides and attributes the right to individual peers to participate in the write or read operations of the blockchain. To provide encapsulation and privacy, reader and writer could also run in separated parallel blockchains that are interconnected." In permissioned blockchain, transactions and members are verified and authorized by Member Service Provider (MSP) instead of anonymous miners (Helliar et al., 2020). Some of the few permissioned blockchain platform include Hyperledger, Ethereum, Quorum, R3 Corda etc.

The advantages of permissioned blockchain for payroll systems are that they avoid the need for environmentally destructive Proof of Work as all network participants are accredited and that it aligns well with real world organisational structure where individual government departments, universities, corporate divisions can run their own payroll with full delegated authority, even during network disruption, while retaining full central oversight and auditability (Ainsworth & Viitasaari, 2017).

In this study we will focus on Hyperledger fabric. Hyperledger Fabric according to Polge et al. (2021) is one of the project hosted by Linux Foundation, a decentralized distributed operating system which executes Distributed Applications (Dapps). Permissioned blockchain can be executed in different ways depending on requirement, however Baliga et al., (2018) identified four basic processes during execution of transaction in the Hyperledger fabric platform, these include; clients initiates transaction then sends to the endorsing peers. The endorsing peers authenticates request and check for client's authorisation then sends back to client. Client collects endorsement then forward to the ordering service to verify and pass to channel. Ordered transactions are then distributed to peers in the network for final check and approval

WHY BLOCKCHAIN IS A POTENTIAL SOLUTION

This section presents how blockchain can be a potential solution when harnessed in payroll systems to improves data security and integrity while at the same time decentralization enhances access and privilege to users. Blockchain relies heavily on cryptographic hash functions to achieve its data security and integrity (Nofer et al., 2017). Hashes are one-way functions that summarise an arbitrary amount of data as a short fixed length deterministically random string, they are used as unique identifiers for data blocks and to establish data integrity and security (Bhutta et al., 2021). The hash of each block is generated from the hash of the previous block the data within the block. This implies that hash values are unique and that can prevent scam since alteration of block in a chain must alter the respective hash value (Nofer et al., 2017).

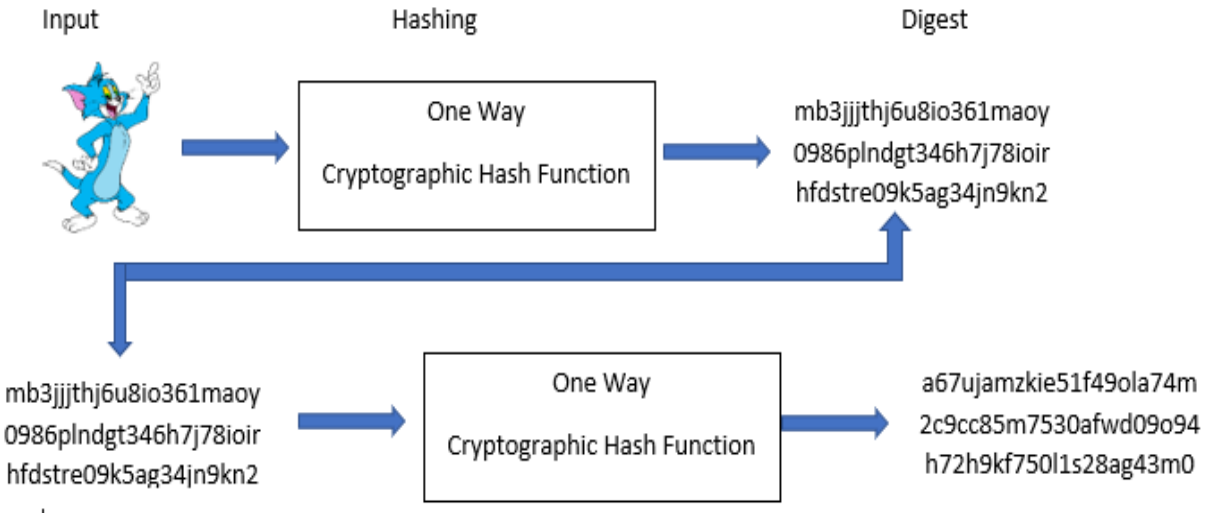

Figure 2. Concept of One-Way function operates

Blockchain implementations are often distributed and decentralized. When a payroll is said to be centralized it implies that every process and transaction such as data capture, data modification, payroll initiation and processing is all done at the centre. According to Yoo (2018) centralized networks are open to attacks because they are dependent on single

central authority. He defines decentralization as the broad dispersion of data within communication systems. Wu et al., (2019) state that decentralization promotes security and democracy in distributed systems. When payroll systems are decentralized, issues relating to data manipulation and to some extent cybercrimes can be drastically reduced or eliminated. This is because Wu et al., (2019) ascertains that no single individual can delete or modify a transaction in the network because transactions require consensus of most participants. In addition, complaints from staff at different geographical locations that are usually reported at the central office can instead be handled by local peers. More so, giving peers privilege of approving transactions will bring the issue of ghost workers to an end since peers in the network approve recruitments unlike before when few selected individuals are in charge. Concerning payroll audit, blockchain can fundamentally change the traditional audit process. Auditors will no longer wait for records from concerned parties as complete record is already stored on the blockchain. Blockchain allows continuous audit for any "on chain" transactions (Liu et al., 2019). Hence integrating the two can make audit easier and more transparent and government or organizations will avoid spending on evidence collection and verification.

CONCLUSION

Permissioned blockchain has become an industrial-driven solution in running business efficiently and effectively (Helliar et al., 2020). The technology has the capability and potentials of solving problems relating to payroll systems such as centralization, data manipulation and inconsistencies, cybercrimes, ghost workers, smooth auditing etc. Permissioned blockchain will establish decentralization, data integrity, data availability, transparency and room for data audit. In this paper we established the potentials and capabilities of blockchain and how it can fit in solving payroll issues. Future research is required to design and evaluate a permissioned blockchain framework for payroll systems.

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