



Developing Countries and Blockchain Technology: Uganda's Perspective

Emmanuel Ahishakiye¹, Ruth Wario², Ivan Niyonzima³

¹(Department of Computer science, Faculty of Science, Kyambogo University,
P.O. Box 1, Kyambogo, Kampala – Uganda)

²(Department of Computer Science and Informatics, Faculty of Natural and Agricultural Sciences,
University of Free State, Private Bag X13, Kestell 9866, Republic of South Africa)

³(Department of IT & Computer Science, Faculty of Computing, Library & Information Sciences,
Kabale University, P.O. Box 317, Kabale – Uganda)

Abstract: Blockchain is receiving ever-growing attention from research and industry and is considered a breakthrough technology. This paper presents an overview of Blockchain Technology and its potential applications in developing countries especially Uganda. It was noted that these nations have the potential to progress, but do not have adequate access to present day technology, primarily due to lack of infrastructure and thus Blockchain Technology will fill the gaps. Fundamentally, these nations need transparency, security, and accountability in their processes, all of which are cornerstones of Blockchain technology. Finally, this paper reveals that due to the support from both government and non-governmental organizations, and the establishment of the Blockchain Association of Uganda, Uganda is ready for Blockchain Technology.

Keywords: Blockchain Technology; Developing Countries; Blockchain; Blockchain Applications

I. INTRODUCTION

Crosby et al. [1] argues that we live our life precariously in the digital world by relying on a third entity for the security and privacy of our digital assets. For example, an email service provider tells us that our email has been delivered, a certification authority tells us that a certain digital certificate is trustworthy, a social network such as Facebook tells us that our posts have been shared only with our friends, or a bank who informs us that our money has been delivered reliably to our dear ones in a remote country. The fact remains that these third-party sources can be hacked, manipulated or compromised. This is where the Blockchain technology comes handy. It has the potential to revolutionize the digital world by enabling a distributed consensus where every online transaction involving digital assets can be verified at any time in the future. The distributed consensus and anonymity are two important characteristics of Blockchain technology.

II. BLOCKCHAIN TECHNOLOGY

A Blockchain is a distributed database of records, or public ledger of all transactions or digital events that have been executed and shared among participating parties [1]. Several studies [2-4] also defined Blockchain as a distributed ledger maintained by network nodes, recording transactions executed between nodes and that information inserted in the Blockchain is public, and cannot be modified or erased. Blockchain allows direct transactions to be conducted between two consenting parties instead of trusting centralized institutions such as a bank to handle the transaction [5].

Blockchain was introduced to the world in 2008 in a whitepaper [5] describing a new kind of electronic currency, Bitcoin. Later, several other use cases for Blockchain emerged. A Blockchain efficiently records transactions between parties on a distributed ledger. The data recorded on a Blockchain is immutable and instantly verifiable. A Blockchain can also be programmed to automatically trigger transactions using smart contract technology. One major reason as to why Blockchain technology is so useful is because it solves the double-spending problem, using a peer-to-peer distributed timestamp server to generate computational proof of the chronological order of transactions [5-6].

Blockchain can be viewed as a gigantic google doc spreadsheet that represents a registry of tangible and intangible assets like currency, documents or physical property [6]. In essence a Blockchain is a distributed ledger, which cannot be changed and can be audited by anyone. The technology can be used for monitoring and tracking assets, information sharing, communication and executing conditioned and long-term contracts [3].

According to Gatteschi et al. [2], the objective of Blockchain was to transfer online payments from one party to another, without relying on intermediaries. The researchers revealed that Blockchain acts as the underlying ledger recording Bitcoin transfers and guaranteeing, by means of cryptographic operations, the



authentication and non-repudiation of payments. Gatteschi et al. revealed the following as the core concepts behind the Blockchain technology.

- **Transactions:** each Cryptocurrency transfer from one subject to another is represented as a transaction from A to B. the Blockchain keeps track of all the transactions occurred from its birth.
- **Blocks:** transactions are grouped in blocks. Each block collects all the transactions occurring in a given timeframe and keeps a reference to the preceding block (This is where the concept of “chain” comes from).
- **Nodes:** instead of being stored in a centralized database, the Blockchain is spread over network computers (the “nodes”), each containing a local copy of the entire Blockchain.
- **Majority consensus:** since a central authority is missing, decisions on the network are made according to a majority consensus. Each node modifies its local copy of the Blockchain to make it mirror the status of most of the network nodes.
- **Mining:** nodes could either passively store a copy of the Blockchain, or actively take part to the maintenance of the Blockchain, in the so- called “mining” process. During mining, nodes check previous transactions to verify whether a subject is entitled to spend a given amount of Cryptocurrency and, each time a block has to be added to the chain, solve a complex computational- intensive mathematical problem. This problem was specifically designed to limit the possibility for a malicious entity to manipulate the Blockchain by falsifying transactions. The probability of attacks is extremely low, since adding a new (malicious) block or modify a previously added block to the chain would require control of most of the network nodes.
- **Wallet:** people transfer Cryptocurrency using wallets. Cryptocurrency cannot be stored on a physical memory; rather, it is the result of previous transactions. Hence, the wallet only stores credentials, which enable Blockchain users to transfer Cryptocurrencies they own. Each wallet is associated to one (or more) unique addresses. Should a user want to send a given amount of Cryptocurrency to a peer, he/she would have to specify the recipient’s address and the desired amount and use his/her credentials to validate the transaction.

To fully understand how Blockchain Technology works, Fig. 1 demonstrates a scenario where Alice wants to send some amount of Cryptocurrency from her wallet to Arthur’s wallet.

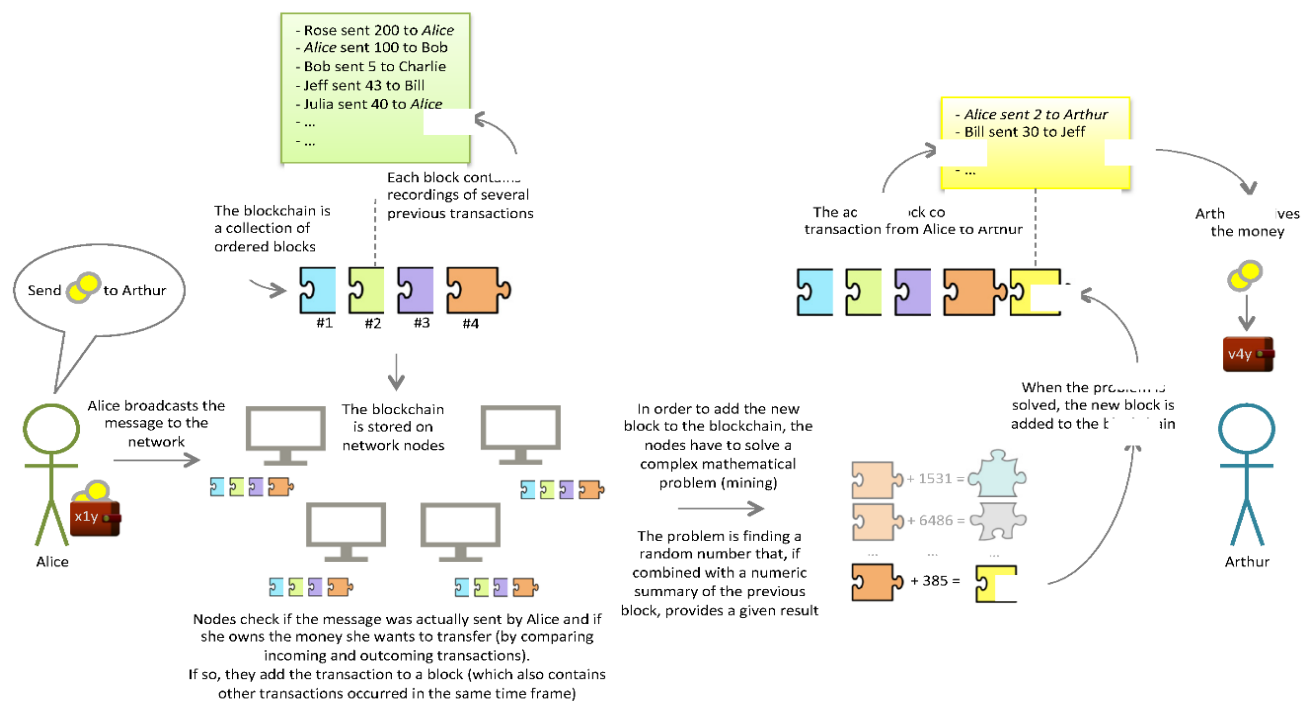


Fig. 1: Performing transactions on the Blockchain, source: Gatteschi et al. (2018)



However, Blockchain technology has also some technical challenges and limitations that was identified by Swan in 2015, as cited by Yli-Huumo et al. [7]. The following seven challenges were identified during the study.

- **Throughput.** As the frequency of transactions in Blockchain increases, the throughput of the Blockchain network needs to be improved.
- **Latency.** To create sufficient security for a Bitcoin transaction block, it takes currently roughly 10 minutes to complete one transaction. To achieve efficiency in security, more time must be spent on a block, because it has to outweigh the cost of double spending attacks.
- **Size and bandwidth.** If the Blockchain needs to control more transactions, the size and bandwidth issues must be solved.
- **Security.** More research on security of Blockchain is necessary.
- **Wasted resources.** The issue with wasted resources needs to be solved for more efficient mining in Blockchain.
- **Usability.** The Bitcoin Application Programming Interface (API) for developing services is difficult to use. There is a need to develop a more developer-friendly API for Blockchain.
- **Versioning, hard forks, multiple chains.** A small chain that consists of a small number of nodes has a higher possibility of a 51% attack. Another issue emerges when chains are split for administrative or versioning purposes.

III. BLOCKCHAIN TECHNOLOGY OPPORTUNITIES IN DEVELOPING COUNTRIES

Developing countries essentially include those nations who are relatively and similarly poor socially and economically. These nations have the potential to progress, but do not have adequate access to present day technology, primarily due to lack of infrastructure. Fundamentally, these nations need transparency, security, and accountability in their processes, all of which are cornerstones of Blockchain technology. The following are the applications of Blockchain technology in developing countries according to researchers and experts.

Naik [8] revealed that Blockchain technology is decentralized and hence eliminates the custodian restraints of any private entity. All the data in the system are digitally crypted for unique identification and once posted, a record can never be changed or deleted, leading to security. Secondly, Blockchain concept works on 'smart contracts', wherein transactions happen only if certain pre-set requirements are met, so there will be accountability of all transactions. Thirdly, the fact that it is an open ledger for all the users in the system to view and monitor, leads to complete transparency.

Castor [9] cites David Crosbie, a lecturer at the University of Pennsylvania who revealed that most of the attention, flurry and investment around Blockchain technology is in the West, where people are investing in cryptocurrencies and focused on a slew of novel applications, like using a Blockchain to track vegetables from the field to store shelves. In relation to developing countries, Crosbie revealed that in places where the state does not provide a good trust model, Blockchain technology can step in and provide a way around existing rules and regulations. He further suggested that "Blockchain provides something fundamentally funded by the end user who provides access, and that enables (documents) to be computerized without the government having to spend the money," [9]. Crosbie further revealed that smart contracts (applications that run on the Blockchain and control the transfer of digital assets between parties) could also provide value in areas where the legal system is too expensive, slow or untrustworthy. And establishing an identity on the Blockchain would be a core part of giving people access to services. All those listed above are the direct applications of Blockchain technology in developing countries since many countries are characterized by corrupt governments and undeveloped infrastructure.

Schmidt and Sandner [10] revealed that institutional weaknesses have multifaceted impacts on people and economies in underdeveloped countries. To mitigate those problems, the researchers suggested three major Blockchain based applications: a property registry, basic legal digital documents and a monitoring system for governmental and institutional spending. Also, the researchers revealed that people in underdeveloped countries often suffer from financial exclusion, which can be solved by the implementation of a distributed ledger based on Blockchain technology. Furthermore, Schmidt and Sandner suggested that farmers could sell their crops directly to the end-consumers without large in between corporations, which dictate prices. The study [10] categorized Blockchain-based applications in developing countries into three principal segments: overcoming weak institutions and corruption, increasing financial inclusion and empowering people.

Lack of transparency, corruption, and misuse of funds are among the challenges that international organizations face when providing cash assistance in developing countries. Blockchain platforms offer transparency and immutability. The World Food Program (WFP) tested this technology in a project called 'Building Blocks', in Pakistan and Jordan where vulnerable families received food and cash assistance from the



WFP, which was authenticated and recorded on a public Blockchain through a smartphone interface. Using this method, disbursements were accountable and matched with the entitlements and the process was faster and more accurate. Therefore, once Blockchain based technology is duplicated in other developing countries, the WFP will have transparency and accountability [11-12].

Blows [13] cites Paul Domjan who revealed that Smart contracts also create an opportunity for developing countries to work more efficiently. These are automated contracts developed on the Ethereum Blockchain, whereby, for example, payment is released to a certain party automatically once all of the pre-determined and agreed upon conditions are met. Even though it could work well in the case of a deed transfer, smart contracts can be used in other industries as well. Blockchain technology can be used to maintain a clear, reliable record of anything. For example, Estonia implemented the BitNation public notary services, including recognizing marriages recorded in the BitNation Blockchain, and Ukraine is developing an election platform based on the Blockchain. All these Blockchain technologies if implemented in developing countries can bring about positive changes in those areas of applications.

Other areas where Blockchain will play an important role in developing countries include the following as extracted from research by [2, 14]:

- **Ease paperwork processing.** Global container shipping still involves a lot of paperwork, costing time and money. Also, paper-based freight documents like the bill of lading are prone to loss, tampering, and fraud.
- **Identify counterfeit products.** Counterfeit medicine is a growing problem for pharmacy supply chains. This especially pertains to expensive, innovative medicine like cancer drugs. Pharmacies have to make sure to sell “the right thing” to the consumers.
- **Facilitate origin tracking.** In the food supply chain, foodborne outbreaks are a challenge for retailers. They have to get a quick overview of where the food came from and which other products are also affected and have to be removed from stores.
- **Operate the Internet of Things.** More and more logistic objects are equipped with sensors that generate data along the supply chain e.g., the status of a shipment. This data has to be stored in an immutable, accessible way.
- **Utilities.** Blockchain can help utilities keep up with rising power demand in smaller, lower-value blocks. Improve existing energy industry processes. React faster after disasters (preventing blackouts).
- **Government.** To record in a transparent way citizens’ votes, or politicians’ programs (for verifying if promises have been kept) or to enable autonomous governance systems.
- **Intellectual property.** To certify the proof of existence and authorship of a document.
- **Internet.** To reduce censorship, by exploiting the immutability of data stored in the Blockchain.
- **Finance.** To transfer money between parties without having to rely on banks.
- **Commerce.** To record goods’ characteristics as well as their ownership, especially for luxury goods, thus reducing the market of counterfeit/stolen items.
- **Internet of Things.** For example, by exploiting smart contracts to automatically process data coming from sensors, to let intelligent machines, interact with each other and autonomously take actions when specific situations occur.
- **Education.** To store information on qualifications acquired by learners. To reduce job application frauds; in this context, multiple actors (e.g., universities, training institutions, etc.) could write qualifications achieved by a person on the Blockchain; human resources staff could then easily obtain information about when and where a given competency was obtained.

IV. BLOCKCHAIN TECHNOLOGY IN UGANDA’S CONTEXT

On the 23rd and 24th May 2018, leaders in policy, business and academia from around the world converged in Kampala, Uganda for Africa’s largest Blockchain conference ever [15]. The conference was organized by The Blockchain Association of Uganda, with support from the Government of Uganda. The Africa Blockchain Conference concentrated on “the role of Blockchain technology in Africa’s transformation and sensitized the participants to realize their role in how to support a thriving Blockchain innovation and business ecosystem in Africa. Dr. Rugunda, the prime minister of Uganda, noted that some of the immediate benefits of using Blockchain in Uganda included enhanced efficiencies with greater transparency and accountability in businesses and governance systems, which are key factors in enabling Uganda to become an investment destination and capturing economic growth [15].

Oketch [16] cites Waiswa, the ICT ministry permanent secretary in Uganda who revealed that the use of Blockchain technology will position Uganda into the global market place, which is largely driven by technology. Waiswa further stated that the government will support [16] any available technology such as



Blockchain to integrate information databases, as to bring about efficiency in public service delivery. He further noted that the government was going to use Blockchain technology where appropriate to provide seamless services to the public, adding that it was time for Uganda to adopt the technology for economic inclusion.

Musoke [17] revealed that Blockchain will save time in Uganda's banking sector, which is dominated by mobile banking commonly known as "mobile money". Mobile banking has security vulnerabilities as the transaction is propagated between the different entities, and this accounts for bottlenecks. He added that participants can move money from a bank account to a mobile money account and vice-versa regardless of telecom network or bank, which currently involves three parties i.e. the bank, the intermediary "aggregator" and the telecom to which the mobile owner belongs. Using distributed digital ledgers like Blockchain, banks and mobile network operators can all be participants in one distributed digital ledger that is transparent to all. This will allow several possibilities like instant transfer of funds from one bank to another or from one bank to a mobile money account without involving an intermediary. Fig.2 shows how a customer can transfer money from their bank account to their mobile money accounts and vice versa using Blockchain technology.

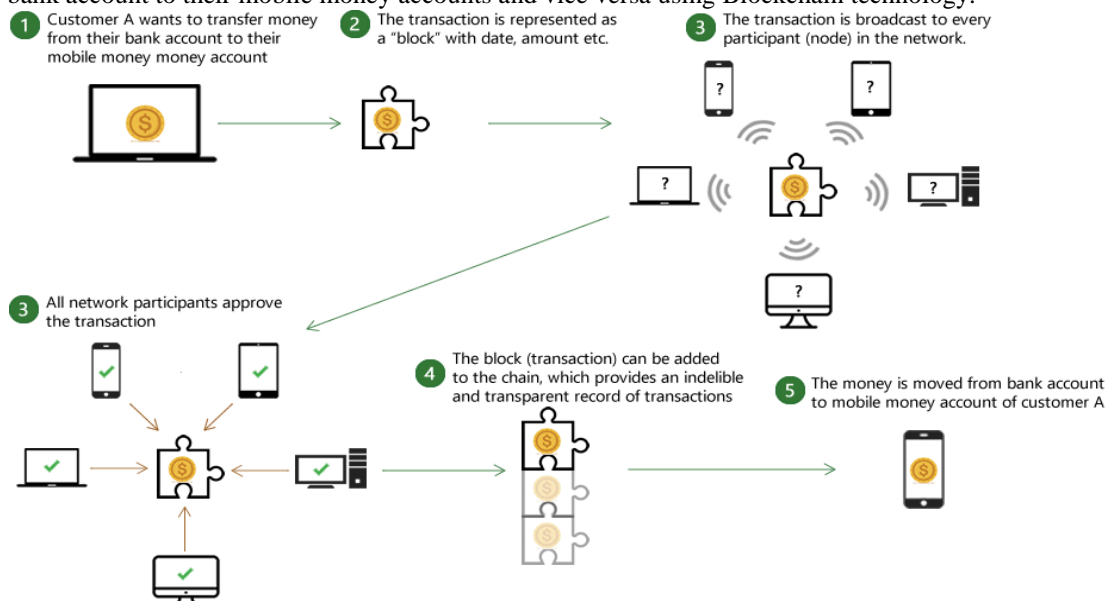


Fig. 2: Use of Distributed digital ledgers on Mobile Banking; Source: Musoke (2017)

During this study, the researchers noted that there were many irregularities in government and non-governmental institutions in Uganda. Recent document forgeries, high levels of corruption, lack of accountability, lack of trust between trading partners, lack of democracy, and fake drugs on the market indicate that it is time for Uganda to take on Blockchain applications. Indeed, it was discussed and agreed by both private and public sectors during the Africa Blockchain Conference that Uganda is ready for Blockchain and now is the time for the software developers to put the concepts and recommendations into reality. The establishment of the Blockchain Association of Uganda whose objectives and goals are to advocate for the development of Blockchain-related industries in Uganda and African territories, serving both domestic and export markets clearly indicates that Uganda is ready for Blockchain technology. The government of Uganda has pledged to support the development [15].

V. CONTRIBUTIONS AND CONCLUSION

This paper highlighted how Blockchain technology can revolutionize developments in developing countries which when utilized. These nations have the potential to progress, but do not have adequate access to present day technology, primarily due to lack of infrastructure. Fundamentally, these nations need transparency, security, and accountability in their processes, all of which are cornerstones of Blockchain technology. Other than banking (finance sector), it has been highlighted from the existing literature that Blockchain technology can be used to solve the challenges that are faced by developing countries especially in Uganda where corruption, forgeries of academic documents and land titles are rampant.

Blockchain is an emerging technology concept that enables the decentralized and immutable storage of verified data. Over the last few years, it has increasingly attracted the attention of different industries. The applications of Blockchain are not limited to cryptocurrencies, but the technology could be possibly applied in various environments where some form of transaction is done. It is noteworthy that developing countries



especially Uganda is ready for Blockchain technology and the government has pledged to give its full support. The study recommends that further research should be done on the implementation of Blockchain technology in various domains to see it coming to reality. Further, teaching institutions like universities in developing countries with ICT programs should integrate Blockchain technologies in their curriculum they are to reap the benefits of this upcoming technology.

VI. FUNDING

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VII. CONFLICTS OF INTEREST

The authors declare no conflict of interest.

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