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Blockchain for Child Labour Decrease in Cocoa Production in West and Central Africa

Rosaire Brice Senou[1,*]. Jules Dégila[1,]**

Esther Chabi Adjobo[1,*]. Abigaïl Priscilla M. Djossou[2,****]**

[1] *Institute of Mathematics and Physical Sciences, African Center of Excellence in Applied Mathematics, Dangbo, Benin*
[2] *African Institute for Mathematical Sciences, Cape Town, South Africa.*
** e-mail: rosaire.senou@imsp-uac.org, PIN: 116164.*
*** e-mail : jules.degila@imsp-uac.org, PIN : 116163.*
**** e-mail: esther.chabi@imsp-uac.org, PIN: 116165.*
***** e-mail : abigail@aims.ac.za, PIN : 116166.*

Abstract: The blockchain technology impacts the supply chain and allows the creation of smart contract. This contract is executed digitally and securely without the presence of a middleman when all requirements are met. West and Central Africa countries produce 70% of world's cocoa, while child labour is an issue as millions of children work in that sector. This paper contribution is mainly to enlighten smart contract adoption with respect to child abuse and to contribute to strategies for child labour reduction.

Keywords: blockchain, smart contract, west and central Africa, cocoa, child labour

1. INTRODUCTION

As Internet grows, new technologies are emerging and changing significantly the ways people interact with their environment, how businesses are conducted and the evolution of the economy. One such disruptive technology is the "blockchain" (United Nations, 2017). Indeed, blockchain is a technology that allows a decentralized environment to be created for the executions of transactions without any means of data alteration (Holotescu, 2018). Therefore, an immutable ledger is used to record the transactions where security, permanency, transparency and auditability are highly adopted. The blockchain was primarily used for financial transaction with the Bitcoin cryptocurrency. As stated in (Holotescu, 2018), there is sometimes a confusion between blockchain and cryptocurrency. The blockchain is a decentralized ledger optimized for the secure transmission of value whereas cryptocurrency makes use of a decentralized system like the blockchain to record transactions (Holotescu, 2018). With the blockchain, security, instant transmission of value and immutability (Olson, E. & Tomek J, 2017) are key characteristics, and several domains can be impacted. The potential use cases are limitlessness (Olson, E. & Tomek J, 2017), starting from the representation, tracking and trading of several types of assets (including government issued money, stocks, bonds, and other financial products), real and intellectual property rights, contract rights, the movement of goods and services across a global supply chain etc. While being referred as 'the Internet of Value' (Olson, E. & Tomek J, 2017) blockchains can be integrated with other emerging technologies such as the Internet of Things (IoT), Big Data, cloud computing, Artificial Intelligence (AI), additive manufacturing, new materials etc.

In West and Central Africa, child labour is a serious issue in the cocoa production sector. This paper is focused on using a smart contract application based on blockchain technology to tackle the issue. This will involve creating a smart contract model that considers the presence or absence of children in the cocoa production sector when a contract is being elaborated. What will the required blockchain technology be implemented with the smart contract? How will the smart contract be deployed? How will the system be relevant or beneficial to farmers and allow child protection or child labour reduction?

2. RELATED WORKS

Child labour is a serious concern all over the world with Sub-Saharan Africa the most dominant region (Esteban O. & Max R, 2018). Several institutions namely UNICEF and ILO (International Labour Organizations) are working to ensure children well-being especially by fighting Child labour. As technology improves, new ways are found to tackle the issue especially blockchain. In Pakistan as specified in (Friebe, 2018), Children are seriously involved in labour to survive, thus leaving school. Helping the children involves setting up a donation system based on blockchain. People will donate to support children so that they can attend school. While they show progress of work at school, the donation will still continue and the donors are also encouraged for showing interest in the cause (Friebe, 2018). Since its invention in 2008, the blockchain have been applied in various use cases of food products (Marten, 2017), including cocoa. The author in (Marten, 2017) showed that Agri Ledger applied

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it to give cocoa producers feedback on product quality based on market prices. According to the author in (Oakes, 2019), more than 100 million children are working in the agriculture sector all over the world with two millions in cocoa sector in the two world leading producers, Ghana and Ivory Coast. Choco4free, a start-up company in Colombia is making use of blockchain technology in order to create opportunities for investors to directly access farmers and finance them if possible (Oakes, 2019). Also, the transparency and traceability that blockchain offers allow investors to trace back the source of the cacao, with the aim of keeping the supply chain child-labour and cruelty-free (Oakes, 2019). In Ghana, the Olam Farmer Information System (OFIS) uses the blockchain to track cocoa from the farm, check cocoa prices and exchange it online at a better price. (Asseh, 2018). Another blockchain usage is related to child labour at cobalt mine (Baydakova, 2019). This issue is seriously reported in the Democratic Republic of Congo and to tackle this, IBM is creating a platform that will make it possible to track the source of cobalt from the mine to its destination (Baydakova, 2019).

2.1 Blockchain overview and applications

The blockchain (chain of blocks) in (United Nations, 2017) is the emerging technology that has gained popularity few years ago (United Nations, 2017). It offers several advantages over database technology as it provides trustless recording of data transaction without relying on an existing intermediary (United Nations, 2017) like a bank in the case of financial transactions. It offers its participants a highly secured ledger system across the distributed network (United Nations, 2017). Bitcoin transaction was its first use, whereas many other potential applications have been found (Rosic, 2018). The blockchain network consists of network of validators called miners, which execute the transaction of any value (Holotescu, 2018) (Olson, 2017).

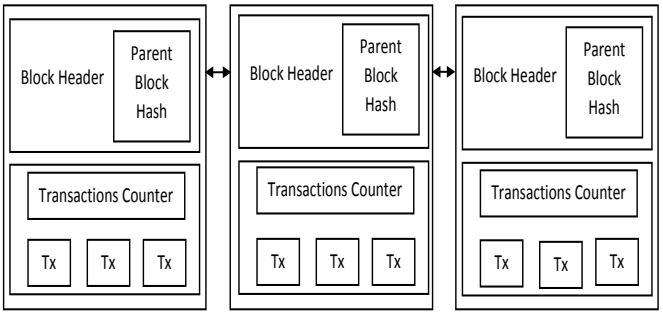

Figure 1: Blockchain sample (Zheng Z. & Xie S, 2017)

Figure 1 is an example of a blockchain. Each block has a previous block hash in the header. The first block of a blockchain is known as the genesis block as all the following blocks come from it. It does not have any parent block (Zheng Z. & Xie S, 2017).

A block consists of a block header and a block body. The block header provides the basic information for data processing with a parent block hash. The latter is a 256-bit hash value that is linked to the previous block (Zheng Z. & Xie S, 2017). It also has a counter and transactions records. The counter simply counts all the transactions executed. The block size and the size of each transaction (Zheng Z. & Xie, 2017) are the parameters that determine the volume of transactions a block can contain.

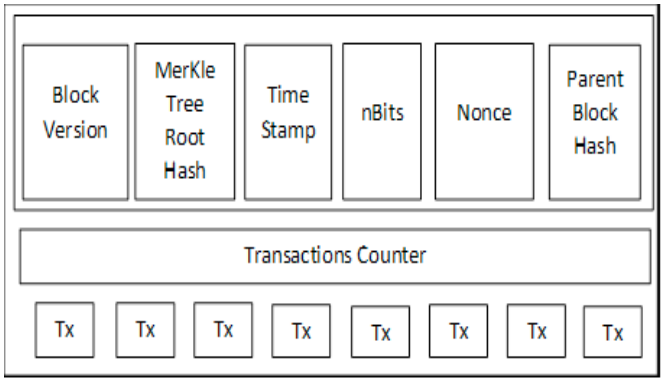

Figure 2: Block Structure (Zheng Z. & Xie S, 2017).

Four main characteristics of blockchain are identified:

- **Immutable**: The transactions executed are permanently recorded with no option of block alteration (Sultan K. & Ruhi U. & Rubina L. 2018).
- **Distributed database**: Each node in the blockchain network has a copy of the existing records. Any node that joins the network can automatically get the records (Houben R. & Snyers A, 2018).
- **Trustful**: There is a consensus model that governs the block validation with no middleman or any central authority required (Olson, E. & Tomek J, 2017).
- **Transparency** – The blockchain data can be accessed any time by anyone for auditions (Holotescu, 2018) and traceability.

2.2 Smart Contract Overview and applications

A smart contract is an executable code that run on the blockchain to facilitate, execute and enforce the terms of an agreement (Alharby M. & Moorsel A.V, 2017) with the aim of automatically executing the contract once the specified conditions are met. According to Josh Stark in (Stark, 2016), two categories of smart contract can be considered, namely, smart contract code and smart legal contract. The author in (Stark, 2016) described the former as a contract that makes use of codes stored, checked and executed on a blockchain. In this type of smart contract, the programming language used to express the contract and the features of the blockchain are the main parameters for its execution. The author in (Stark, 2016) continues with the smart legal contract which means codes to complete legal contracts. This type of smart contract depends solely on legal, political and business institutions.

According to (Patel D. & Shah K. & Shanbhag S, 2018), smart contracts cannot be enforced in some of the existing judicial frameworks. Therefore, frameworks to create and execute legally binding smart contracts can be proposed in order to cope with the context (Patel D. & Shah K, 2018). According to (Bartoletti M. & Pompianu L, 2017), six platforms are considered useful for smart contracts as they are already launched, running and supported by a community of developers and accessible to the public. Bitcoin and Ethereum are by far, the most used with Ethereum the first choice. In Ethereum blockchain, blocks consist of transactions that can be transfer of ether or data. The blocks have limit upon the transactions that can be stored. For smart contract, data/codes are used in transactions. Thus, all accounts with codes stored are contract accounts or else, they are considered as externally owned accounts. The later are accounts that belong to individuals on an Ethereum

platform with ether in their balance and no code is associated with them (Modi, 2018).

Table 1: General statistics of smart contracts platforms (Bartoletti M. & Pompianu L, 2017)

Platform	Blockchain			Contract Language	Total Tx	Volume (K USD)	Marketcap (M USD)
	Type	Size	Block Int.				
Bitcoin	Public	96 GB	10 Min.	Bitcoin scripts + signatures	184,045,240	83,178	15,482
Counterparty				EVM bytecode	12,170,386	33	4
Ethereum	Public	17-60 GB	12 sec.	EVM bytecode	14,754,984	10,354	723
Stellar	Public	?	3 sec.	Transaction chains + signatures	?	35	17
Monax	Private	?	Custom	EVM bytecode + permissions	?	n/a	n/a
Lisk	Private	?	Custom	JavaScript	?	45	15

Smart contract has several applications including voting systems, banks, automobile, real estate, digital rights management, supply chain etc. (Alharby M. & Moorsel A.V, 2017) (Blockgeeks, 2018).

3. PROBLEM DESCRIPTION

Most of the world cocoa production (70%) comes from West Africa more specifically from Côte d'Ivoire and Ghana (Omnitude, 2018). The children traditional role in cocoa plantations is a challenge (Coabiso, 2011). Involving younger family members in agricultural tasks is one of the first steps in transferring responsibilities to younger generation in the famers' family. However, surveys commissioned by the governments of Côte d'Ivoire and Ghana have revealed that too many children are engaged in an unsafe agricultural work, using unsafe agricultural tools or participating in the application of pesticides (Coabiso, 2011). These children are often victims of work accidents and diseases during agricultural work (Coabiso, 2011) instead of going to school. Some children work for 100-hour-long in a week and are also subjected to physical abuse (Mattyasovszky, 2018). Despite more than a decade of efforts to fight the exploitation of children in cocoa plantations, the number of working children is still too high (Omnitude, 2018) (Oakes, 2019) - and as cocoa production increases, the number of working children increases. No company or government has achieved the overall goal of eliminating child labour, or even the commitment to reduce it to 70% by 2020 (Omnitude, 2018). Building schools and educating children are adaptive solutions to reduce child labour (Guilbert, 2016) but other means can also be explored. In this this article, a technological solution based on blockchain and smart contract is proposed. How will this smart contract model based on blockchain be used in elaborating a better strategy for child labour diminution?

4. METHODS

In order to achieve the target, which is reducing child labour in cocoa production sector with blockchain technology, a smart contract model is proposed. First, we conducted a survey on existing works related to child labour and blockchain. This is to ensure the originality of the proposed model. Books, articles, websites and others files were explored. Secondly, a set of questions necessary to assess children well-being has been derived for the sake of the smart contract. Thus, the model is based on conditions that have to be satisfied before a contract is concluded. It relies on the set of questions made available in the blockchain for the farmers to answer in order to get the right to farm. As the blockchain is immutable and highly secured, it will help making the recorded data unfalsifiable. The questions are asked either by the cocoa board members or by resourced people. Farmer's attention is drawn to the importance of the data they provide while ethical behavior is expected. If possible, a survey can be initiated to confirm farmer's righteousness. Also trusting the cocoa members or authorities, or adequate farmers include choosing people that are ethically minded for data input and future inspections (Baydakova, 2019).

When the conditions are satisfied, the smart contract is concluded and the farmers are granted or not full permission for farming or permission with advices or warnings. This smart contract model is supposed to be implemented before any crop season starts for a successful and less harmful season and to ensure farmers commitments, experience can be used. This experience approach will emphasize the quantity of cocoa for instance a farmer might produce per hectare with a certain number of workers. With these informations known, a higher production than the usual can be further analyzed to ensured farmer's honesty.

As the blockchain is based on a distributed computer network, powerful servers will be installed at farmer's association company or/and at the coco board offices and interconnected with a high-speed connection across the country. Here are some minimum characteristics of a sample server necessary for mining: storage – 2TB, CPU - core Intel Core i3-7350K – i7-6950X, RAM - 16 GB, Graphics: AMD Radeon RX 480 – 2 x Nvidia Titan X (Hanson, 2018). These types of computers are necessary in order to allow a high processing power and a high data storage. **Figure 3** represents the proposed smart contract model. The farmer's eligibility is based on the answers obtained. At each question no matter the answer (yes or no), an action is taken or/and the next step is followed till the last question. After the execution of the last question, all comments are grouped and summarized in a file, with the final decision.

In this smart contract model, the farmers and the children are the most concerned. In the first step, Farmer's registration is compulsory. If the farmer is not registered, the contract should not be concluded. The registration is necessary to have a global view of all people involved in the activity. The second step in the smart contract model is related to children enrolment. At this level, a negative answer ends the contract while a positive answer will need a comment. Therefore, if the farmer uses children in its production, some advices or warning are given. A fine comes to play with traficated children are used or others irregularities detected with respect to the law. The Yes or No scenario continues throughout the model till the end. Third, the age condition is a parameter that will limit or avoid vulnerable children between 5 to 11 years to be enrolled in the activity because the International labour organization (ILO, Hazardous Child labour, 2018), stated that children between 5 and 11 years in hazardous work have increased from 2012 to 2016 and the agriculture sector uses the most, children within that range of age. They represented 34.08 percent of its total children employment. The Last steps, School education, injuries and exposition to pesticide are others factors that will require serious actions in case of any attitude affecting the production or children. As soon as the last question is answered, there is a text summarizing all the answers with the final approval which would be based on the numbers of yes or no obtained from the answers. The smartness of this type of contract come from the fact that there are no more documents to be used as to provide a file in

order to get the government approval or assistance for farming. All the people involved in providing those documents are left outside. The farmer only needs to move to the registration area and get enrolled for a formal contract. This reduce the whole farming process.

With this blockchain and smart contract installed, one of the challenges will be the training of the actors (farmers and coco board employees) for using the infrastructure as most of farmers are less used to informatics (Asseh, 2018). Another challenge will be the availability of high-speed connection and electricity for server installation in rural areas, given that the farmers association offices might not be always in town with easy access to network resources. However, implementing this blockchain smart contract model will promote better children care. The blockchain infrastructure can also be used for financial transactions between farmers, farmer's associations and the government

5. EXPERIMENTAL RESULTS

The execution of this smart contract model provides a secure way of reducing child labour usage. The following are the possible results from the questionnaire.

Table 2: Possible outcome of the questionnaire.

Questions	Answers	Comments
Is the Farmer registered?	Yes	The next step is followed
	No	Must be registered
Are children employed?	Yes	Next step is followed
	No	No Contract is concluded
Age requirements (above 12 years old)	Yes	Null
	No	Warning: Avoid using children under age.
Do Children go to school?	Yes	Null
	No	Warning: school education must be provided.
Have Children been ever harmed?	Yes	Advices: make sure to teach children about the way the work should be done.
	No	Null.
Are they protected against pesticides?	Yes	Accountability
	No	Warning: Uniform must be urgently provided for the children.

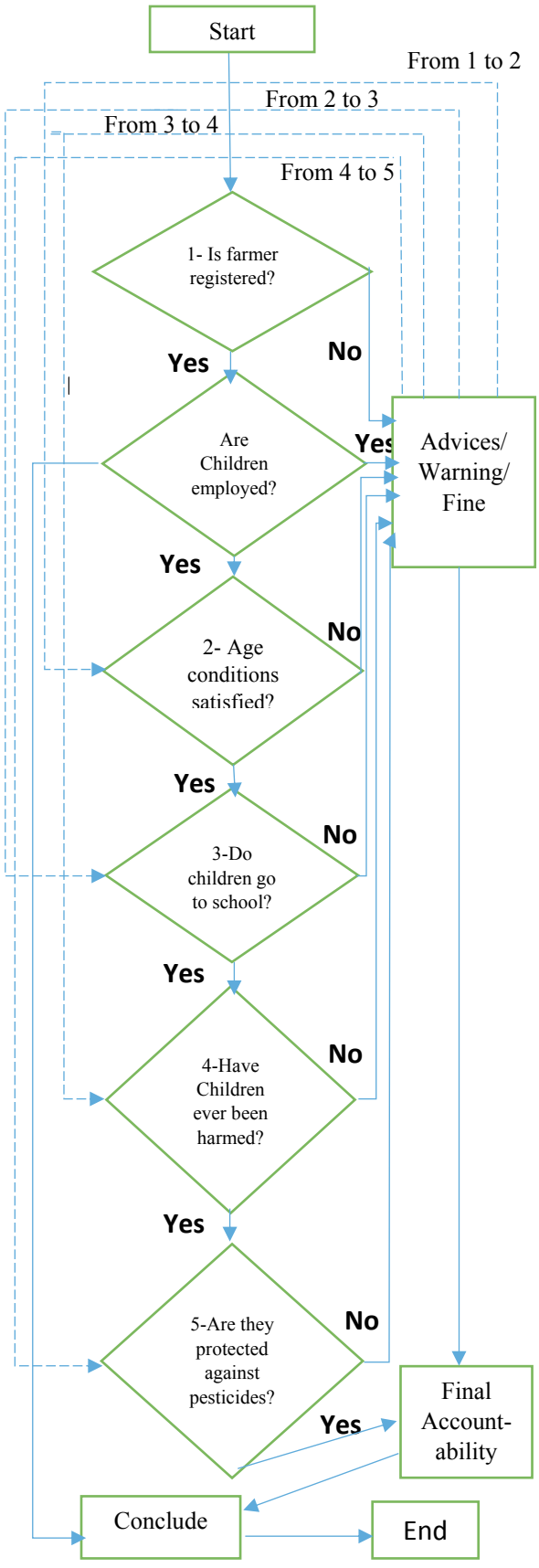

Figure 3: Smart contract model

From table 2, implications are derived as a result of different scenarios cases of results.

1- As theoretical implications, the following are considered:

- A farmer that benefit only advices show care for children. He impacts children positively and contribute to their well-being.
- Farmer who does not satisfy any requirements warning need to be seriously educated about children well fare as he does not show much concerns. His case is important and must be reviewed frequently. He could be highly fined if other irregularities are discovered like an increasing number of children in the farm.
- For Farmers that partially satisfy the requirements, advices and warning are provided accordingly. This has to be further analysed in order to provide better options for children safety.
- The absence of small children can be noticed in the farm and the involved ones are more protected in the different works.

2- As practical implications, these considerations are taken:

- Smart contract is a contract though it's yet to be enforced in the law. Therefore, its deployment would need actors to initiate a draft that would govern for the mean time the process.
- The technology usage to improve farmers and Children well-being is appreciated.
- As data are stored in the blockchain, different analysis could be made from it with the aim of conducting others surveys or taking decisions.
- The deployed infrastructure can be used for other purposes, financial transactions for instance and it will also ensure the development of the regions or cities involved.
- The collected data within the blockchain could be used for farmers encouragements. Indeed, the farmer with a less harmful season can be encouraged to persevere in that direction through a recognizing ceremony.

Based on the following results and implications, children situation can be improved in the cocoa farm and this contributes to social welfare. The blockchain is helpful because of its transparency and immutability (Holotescu, 2018) (Sultan K. & Ruhi U. & Rubina L. 2018) and a smart contract is used to reduce child labour by permitting farmers to farm upon satisfying certain conditions defined in the smart contract code. This smart contract application guaranties the right to farm against children welfare. Therefore, with its utilization, in West and Central Africa, not any child will be found farming, but only those who benefit favorable conditions for their well-being. Also, time saving and energy are noticed with smart contract as processes are optimized leading to better time management and people's happiness.

6. CONCLUSION

This work was mainly focused on a smart contract model based on blockchain that reduce child labour in the cocoa production as children have been involved in the sector and do not benefit better care. Since smart contract in blockchain allows the execution of contracts when the requirements are met, the conditions in this case are the values submitted with respect to a questionnaire answered by the farmers. A fine aspect is also considered with respect to complicated situations involved, making it more effective. We believe that this will provide valuable information for engaging farmer's into righteousness as they perform their relevant task.

As future work, though blockchain is evolving seriously, it is still not adapted that much in Africa. It would be relevant to analyses the challenges and opportunities of its integration in existing IT infrastructure in West Africa and how far the main drivers have succeeded. Other studies could be narrowed down to the optimization of the existing cocoa supply chain in the producing countries and we can differently look at the implementation of the proposed smart contract model using a smart contract platform like Ethereum. As the legal aspect of smart contract is still a hot topic, it would also be important to see how best a law could be established to govern this type of contract in the cocoa sector. Finally, looking at contract management, other studies can be conducted to see the effect of smart contract on existing contract methods in this or other agricultural sectors (promises, benefits, disadvantages).

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