Procurement Master

(Smart Contract Based Public Procurement to Fight Corruption)

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PROBLEM STATEMENT

Most African governments are trying different measures to eliminate corruption, bad governance, mismanagement and lack of accountability in their countries but these efforts are mostly unsuccessful. As a tool for change, blockchain can help in solving some of these governance issues plaguing Africa.

Task:

With this in mind, think of a way you can implement a smart contract that can help eliminate any of these ills, then implement it using Plutus.

KEY TAKEAWAYS

- The precision, provenance, clarity and automation features of blockchain could save Africa billions of dollars lost because of corruption, bad governance, mismanagement and lack of responsibility.
- Areas like procurement, Land and property administration, and duty administration could profit greatly.
- Implementation and use of blockchain could contribute to general behavioral change in the African society.

Abstract

Corruption in public procurement is a worldwide appearance that causes immense financial and reputational damages. Particularly, in developing countries (majorly Africa), bribery is a widespread issue due to secrecy and lack of transparency. An influential mechanism for transparency and accountability assurance is the record which is grasped and controlled by record-keeping systems. Blockchain technology and more exactly blockchain-based smart contracts are rising technological tools that can be used as record-keeping systems and a tool to alleviate some of the fraud connecting public procurement records. Immutability, transparency, distribution and automation are some of the traits of smart contracts already applied in various applications to avoid malicious human interfering. In this paper, I discuss some of the swindles in public procurement, and I recommend smart contracts to automatize dissimilar stages of the public procurement technique attempting to fix their major contemporary weaknesses. The processes I have focused on include the tendering process, supplier habilitation and delivery verification. In the three subprocesses, common irregularities include human unreliability, improper information disclosure and hidden agreements which concern not only governments but also civil society.

Introduction

The World Economic Forum recognizes that “public-sector corruption is the single-largest challenge, stifling social, economic and environmental development. Often, corruption centers around a lack of transparency, inadequate record-keeping and low public accountability”. Frauds in public procurements have been an issue for all countries but the social impacts are more visible in the Global South. According to, in developing countries “the impacts of corruption severely and disproportionally affect the poorest and most vulnerable in any society, and when it is widespread, corruption deters investment, weakens economic growth and undermines the basis for law and order” (p. 3). Public money diversion through public procurements is a common practice in developing countries and the numbers show that this practice implies the majority of public money diversion in the world.

Distributed Ledger Technology (DLT), the more general term for Blockchain, has been showing potential to mitigate some fraudulent practices, especially those involving the recording of financial flows. The features of DLT such as decentralization, distribution, immutability and transparency are mechanisms to mitigate some of the common fraudulent practices involving public procurements and to promote greater transparency and accountability. Several initiatives have been implemented in different countries using DLT and blockchain-based smart contracts to mitigate some of the frauds involving public procurement however no one of those initiatives focused on the recordkeeping features of the technology. In this work, we propose a prototype to automatize the recording of some transactions using smart contracts to cover parts of the public procurement procedure aiming to reduce the fraud opportunity. The selection of specific stages was necessary given the complexity of the entire public procurement and the particularities of the

different procedures over the world. The three stages covered by our prototype were based on records forgery and undue information disclosure.

Public Procurement Process and Current Issues

According to the Organization for Economic Co-Operation and Development (OECD), public procurement "refers to the process of identifying what is needed; determining who the best person or organization is to supply this need; and ensuring what is needed is delivered to the right place, at the right time, for the best price and that all this is done in a fair and open manner" (p. 6). The public procurement procedure varies from country to country, but there are international standards and guidelines to guarantee a fair and transparent process in different jurisdictions such as the OECD Recommendations on Public Procurement and the World Bank procurement Framework. Even though the different jurisdictions and different procedures, there are commonalities among the public procurement practices as the application of basic principles such as transparency, overriding public interest and competitiveness. The basic procedure for public procurements should present, according to the OECD, transparency, integrity, access, balance, participation, efficiency, e-procurement, capacity, evaluation, risk management, accountability and integration.

Design of Selected Aspects: Bidding, Supplier Habilitation and Delivery Verification

Bidding Process

During the bidding process, participating companies submit their offer. For simplicity reasons, I assume that the cheapest offer wins the bidding, and this company is chosen as the preferred supplier. As mentioned above, to avoid disclosure of competing offers the bidding must

be conducted with confidentiality. Algorithm 1 shows the pseudo-code of this process. Since I assume the use of a public blockchain, no price information should be transmitted or stored in a smart contract. On the other side, it must be ensured that a company cannot change the price after the offer has been submitted.

Algorithm 1:*Smart Contract Place Bid*—places bid and stores the hashes of the bid and offer document in the smart contract

```
1 input: bidding hash, offer hash, tender, sender
2 if status of tender is propose (tender) AND not duplicate bid (sender)
3     store (bidding hash)
4     store (offer hash)
5     lock deposit (sender)
6     register bid (sender)
7 end if
```

Supplier Habilitation

Government must assure that suppliers participating in public procurement are compliant with several legal prerequisites. These can be general aspects, such as the correct payment of taxes or compliance with working conditions. However, these prerequisites can also be tender-specific, such as quality seals or permission to manufacture medical devices. Most of those requirements are not bound to one specific tender but can be reused for multiple calls. I use the concept of self-sovereign identity to solve this aspect. Each vendor can create its own identity. This identity is certified by an official body with proof that is stored on the blockchain. Additional certifications

can be bound to this identity by authorized issuers. All certifications are stored on the blockchain. During the verification phase of the procurement, the required certifications are checked without the involvement of the individual issuers. Certifications can have an expiration date or can be revoked. Even the connection to identities on other blockchain systems can be applied.

For the procurement and bidding process, this means that only vendors who can prove all required claims are considered as winning providers (see Algorithm 3).

Algorithm 3: *Smart Contract Supplier Habilitation of the Winner*—verifies that the winner of the bidding meets all requirements and places the order

```
1  input: winner, tender
2  if status of tender is reveal (tender)
3     if all requirements met (winner)
4        winner approved (winner)
5        place order (winner)
6        lock payment (getPrice (winner))
7     else
8        mark next winner (tender)
9        call supplier habilitation of the winner
10    end if
11 end if
```

Delivery Verification

After the cheapest bid has been selected and the order has been placed the next crucial part is the verification process of the delivered goods or services. Even if the tender process has been fair and accurate the receipt of the delivery contains many possibilities for manipulation. This ranges from the absence of individual goods to non-compliance with quality requirements to the complete lack of delivery. Since a smart contract will never be able to verify the diversity of possible features of physical goods, again an oracle service comes to the application. This time a "human oracle" is used. This means that persons must verify and evaluate the delivered goods or services. To reduce the possibility of corruption the double-check principle is applied. The smart contract chooses randomly two or more auditors from a set of predefined persons. Due to the random selection and the transparent and immutable documentation of these auditors, the chance of intentional misstatements is reduced to a minimum. Only when both auditors have positively assessed the delivery, the payment of the goods is triggered. In the event of a complaint, an external arbitration process is triggered (see Algorithm 4).

The payment is processed by the above-described smart contract that locked the payment at the time of the order. This reduces a further possibility of fraud: the suspension or prevention of payment. Since the buying party must deposit the agreed amount in the smart contract after delivery verification is successful and signed the payment is automatically processed and no interference or delay is possible.

Algorithm 4: *Smart Contract Order Verification*—verifies the order and releases payment

```
1 input: tender
2 prerequisite: only buying party can execute
3 ifstatus of tender is evaluate (tender)
4     repeat
5         select auditor randomly
6         wait for validation of auditor
7     until number of validations reached
8     if all validations correct
9         release payment
10     else
11         start arbitration process
12     end if
13 end if
```

Proposed Process and Recordkeeping

Recordkeeping was a term revisited in the 1990s because of the emergence of electronic records. According to "electronic recordkeeping became a widespread term, used to mean the application of recordkeeping strategies to digital records and systems" (p. 321). According to the International Council on Archives (ICA), a record is a document "created, received and maintained as evidence and information by an organization or person, in pursuance of legal obligations or the transaction of business" and a recordkeeping system is defined as "a framework to capture, maintain and provide access to evidence of transactions over time, as required by the jurisdiction

in which it is implemented and in accordance with common business practices". The definition proposed by the ICA is beyond the concept of software or an application and involves the policies and procedures established for records management.

Regarding the trustworthiness of the records produced and kept by our solution, we aim to guarantee their reliability in controlling the process of their creation. Using smart contracts, we aim to guarantee that the process to record parts of the procedure is achieved according to the public procurement regulations. In the first smart contract related to the best proposal selection, our prototype selects the lower value proposal and records the result of that transaction on the blockchain according to specific rules. The second smart contract checks the authenticity of the records presented by the winning bidder to execute the habilitation check transaction through an external call to a public agency database (e.g., a call to the revenue agency database to verify the authenticity of a tax regularity certificate). The process implies the verification of the identity of the records and their integrity. This checking process must be registered in the public procurement documentation, and it is not possible to award a contract between the government and the winning business without recording the checking transaction. This phase also implies the reliability of the record produced as an outcome of the habilitation records check smart contract since it follows the regulated procedure to attest to the veracity of the certificates presented by the winning bidder. Finally, the delivery verification process can assure the reliability of the outcome of the third smart contract of our prototype. The delivery is certified by a randomly designated public agent and the recording of that information is also controlled by an automatized process following the specific rules for that stage.

Prototype Implementation

To verify the concept and to receive feedback from possible users of a smart contract-based procurement process, I implemented a prototype using the Node-RED framework and the Ethereum blockchain. Node-RED (**https://nodered.org/**, accessed on 4 May 2022) is an Open-Source flow-based graphical development system that is ideal for prototyping processes. It is commonly used for Internet of Things (IoT) applications since it offers a huge variety of implemented nodes for transaction protocols. In addition, there exists a dashboard node-set that makes it possible to easily build a simple user interface (**https://flows.nodered.org/node/node-red-dashboard**, accessed on 4 May 2022).

Prototype source https://github.com/harst100/Procurement-Master/blob/main/procurement-master.zip

Conclusions and Further Work

From an Archival Science perspective, we can assume blockchain systems could be compared to recordkeeping systems in the sense that they can "capture, maintain and provide access to records over time" as long as the requirements for the creation, maintenance and preservation of those records are considered from the beginning of the information system design. Some of the records' intellectual components are present in our prototype but there is still some pending process to establish the archival bond and maintain the records' contexts, especially regarding the link between the on-chain and the off-chain records produced and kept in different information systems throughout the public procurement procedure. Our research must pursue the requirement for

trustworthiness and long-lasting records to establish a recordkeeping system for public procurement records in blockchain environments.

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