International Journal of Artificial Intelegence Research
Vol 6 No 2, December 2022
ISSN: 2579-7298

Smart Contract Blockchain Application Design Based on The Distribution of Product Return Transaction Data

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ARTICLE INFO

Article history:
Received 04 Apr 2022
Revised 28 June 2022
Accepted 20 July 2022

Keywords:
Blockchain application,
Distribution transaction data,
Return sugar product,
Smart contract

A B S T R A C T

In 2020, there will be 1% bulk sugar product returns. Direct return to warehouse; it is not known how much and what kind of sugar was returned. Changes in the number of uncontrolled product availability occur in the logistics sector. We designed a sugar volume return mechanism to verify the identity of the buyer, the amount and time of the transaction, using the steps of investigation, analysis, and system design that can implement. The application is based on the truffle test framework and smart contracts on the Ropsten test network on the Ethereum Metamask platform wallet, localhost memory, and a decentralized web-based dashboard. Input data on the smart contract so that during the Ropsten net test process, it will generate blocks, hash codes, and contract hashes as transaction details. It also displays a summary report and a blockchain transaction dashboard. How much volume will increase or decrease due to returns, buyers, type of sugar commodity, time, and volume of sugar during data transactions is known. The features developed for smart contracts are private, semi-public transactions with consensus proof of work as validation and verification of the success of transaction data records.

I. Introduction

Today, a significant challenge for entrepreneurs and processing plants is to share trust. Because we have to reduce the frequency of meetings and mobility outside the home, all transactions are made online. In the supply chain, the movement of products from one entity to the next requires coordination reaches the end-user without any damage or discrepancies. Problems commonly occur in the supply chain, such as lead time on product delivery, chain length, fraud, lack of accurate data authentication between actors, management, and data integrity [1]. Based on the phasing and determination of priority industrial development, sugarcane-based sugar is one of the products of the priority industrial development stages in information technology [2]. The development, mastery, and utilization of industrial technology are carried out in stages by the development of science and the needs of the domestic industry to increase efficiency, productivity, added value, competitiveness, and independence of the national industry.

The need for sugar derived from processed sugar cane increases for direct consumption and as industrial raw materials. White crystal sugar, produced from processed sugar cane, is increasingly demanded by direct consumers and the industry. National sugar needs currently reach 6 million tons per year, consisting of 2.7-2.9 million tons for consumption sugar and 3-3.2 million tons for industrial sugar. The average domestic consumption of white crystal sugar (GKP) is 2.1-2.2 million tons, and the national refined crystal sugar (GKR) production is 3.3,2 million tons [3]. Global agricultural industry trade is increasing in terms of the quantity demanded by consumers. Therefore, proposed information technology-based solutions can help improve the processing of agricultural commodities at the production process level [4]. Currently, the agricultural and processing industries still use traditional technology systems in the production process and information systems [5].

The return of sugar products appears if the sugar purchased from the producer does not meet the quality standard specifications according to the buyer, such as color, shape, or taste [6]. If this happens, producers get the opportunity to recycle or replace packaging [7]. The framework governing reverse logistics product returns is based on the heuristic decomposition method [8]. At the same time, the functional integration of operations marketing can create a higher level of customer value described through a conceptual framework [9]. To find the optimal return time and order quantity value using a mathematical model [10]. The research gap that has not been addressed to date is using blockchain smart contract applications for transparency in returning sugar products. The accuracy of quantities in factory logistics can be traced.

The use of blockchain technology in agro-industrial supply chains will change the practice of data distribution transactions [11], by executing smart contracts as transactions [12]. Transactions are carried out securely using information technology infrastructures such as web-based, IoT, internet, and QR Code [13]. The blockchain works based on distributed trust, updated via a consensus protocol that ensures consistency and integrity through distributed network nodes [14]. Transaction records stored in the blockchain can reduce errors due to the immutability of the blockchain so that the transparency of data transactions that occur can increase the effectiveness of performance between divisions [15].

Logic-based blockchain smart contract programming is performed between actors defined on the system [16]. The application runs on localhost memory for each division with views in HTML and the react library. At the same time, the database is based on MySQL and the application blockchain on the Ropsten Metamask Ethereum platform [17]. Smart contract application developed through the Ropsten Metamask platform on the Ethereum Blockchain application [18]. Smart contracts are very efficient because they do not rely on intermediaries, save paper, time, and costs, and reduce manual operation errors [19]. Meanwhile, the weakness is that the perpetrator cannot guarantee authenticity, so if there is a fraud, it is challenging to investigate, and the government it difficult to tax the transaction [20].

The logistics division only records transaction history regarding incoming sugar stocks, remaining stock, and product returns in the warehouse. Product entry and exit processes that occur are based on the first-in-first-out principle, and only logistics operators can input data. At the same time, other divisions can only monitor inputted data. In this study, we propose a blockchain smart contract design that makes transactions between sugar factory divisions transparent. The steps for the record return mechanism for the amount of sugar from the buyer are inputting the buyer's data, order number, date of type of sugar, amount of sugar returned. After that, the record will increase the amount of stock in logistics. Based on the explanation above, the purpose of this research is to design a blockchain-based smart contract application to monitor product availability transparently and track the accuracy of the time and amount of sugar product returns.

II. Methodology

This research is part of a dissertation to develop a supply chain system based on blockchain technology, especially for sugar product returns. The data collection process began with an initial survey of sugarcane processing and planting locations in January 2020 by conducting interviews with farmers, workers, and communities around PG. From November to December 2020, we conducted official data collection at PT XYZ II City C and PG JT City M. Due to the pandemic conditions and restrictions on activities and interactions, we will conduct online discussions via WhatsApp, telephone, email, or zoom; if there is still a lack of data,

The steps we are take reference the system development life cycle (SDLC) method. The stages include four stages [21], namely the stages of investigation, analysis, design, and implementation in sequence. Must review Each completed step must ensure that the step has been carried out correctly and as expected. If not, then the step needs to be repeated again or back to the previous step [22]. The SDLC cycle is described in the following research flow:

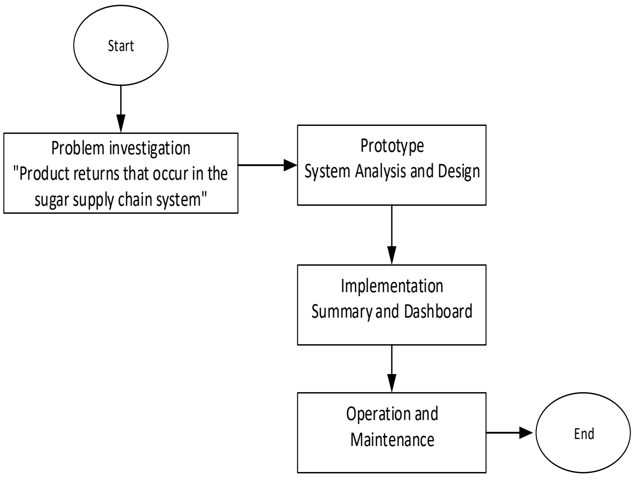


Fig. 1. Research flowchart

Based on Figure 1, the research begins by investigating the problems that occur in the sugar factory. The problems that arise based on the results of visits and interviews at the head office and PG are: that in the 2020 milling period there are about 1% of sugar product returns, due to the return of new buyers who feel that they do not meet the sugar quality specifications, besides that there is non-transparency, such as the amount of product volume and type, product returned to the warehouse is not known which buyer came. The time of product return is not recorded correctly. Then we designed a technology that can streamline the traceability process, namely blockchain based on smart contracts, to monitor and control the management. The proposed decentralized PG information system will increase the transparency of data records to trace them if problems occur along with the supply chain flow. In PG, this can be a pilot project for a national agricultural product holding company.

Figure 2 describes the system architecture that will build based on blockchain smart contracts. Logistics users sign in to input the return data record through the localhost:3000 browsers, which runs on the Ropsten Metamask Platform. And the architecture is built with react.js as the backend as an application library (kitchen). Also, the frontend is displayed with a dashboard as monitoring and controlling data transactions that occur in PG JT.

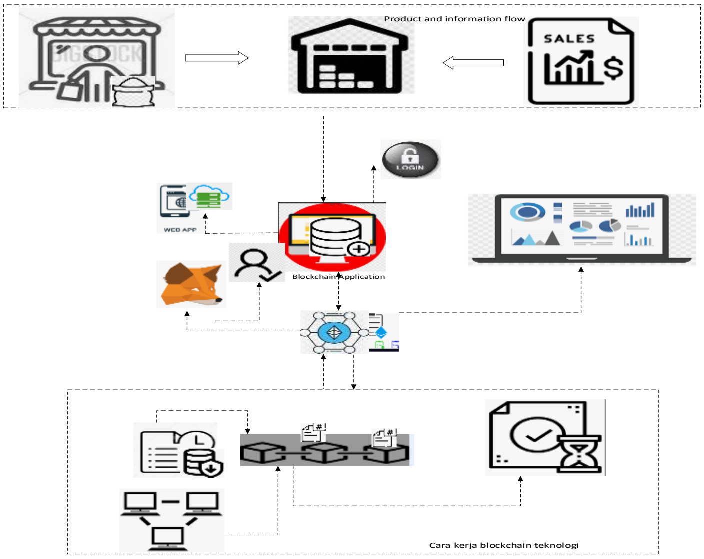


Fig. 2. Blockchain-based product return framework architecture

III. Result and Analysis

The agroindustry supply chain system designed consists of production, logistics, and sales. Where the sugarcane produced comes from smallholder plantation farmers, PG, and private ownership. Farmers send sugar cane to PG to be processed into white crystal sugar and in 2020.

There will be mills other than sugar cane, namely raw sugar, to meet national needs. In addition, there was a sugar return of around 1%, which was the first time experienced by PG. The non-transparent return process causes discrepancies in the accuracy of the data on the amount of sugar in the logistics. The major party cannot trace which buyer returned the sugar and from which type of sugar commodity was returned. Because there is no technology used in the factory, we use PG JT as a pilot project for implementing smart contract blockchain, with an overview of the initial system tracing.

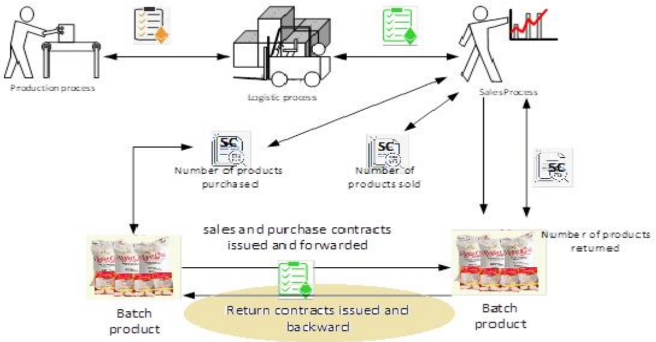


Fig. 3. Investigation of the supply chain system for sugar product returns

Figure 3 states that the seller sends sugar to the buyer according to the initial agreement that both parties have agreed. Product returns occur, the buyer returns the bulk sugar product to the factory. Then the factory will repackage it and will resell it by the sales division to other buyers.

Business process analysis is carried out using use cases and Business Process Model and Notation (BPMN)[23]. One of the critical diagrams used to illustrate the system's requirements is a use case diagram, which visually describes the context of the interaction between actors and the system [24]. Use cases are described textually in use case scenarios to explain the interactions between actors and the system to be developed [25].

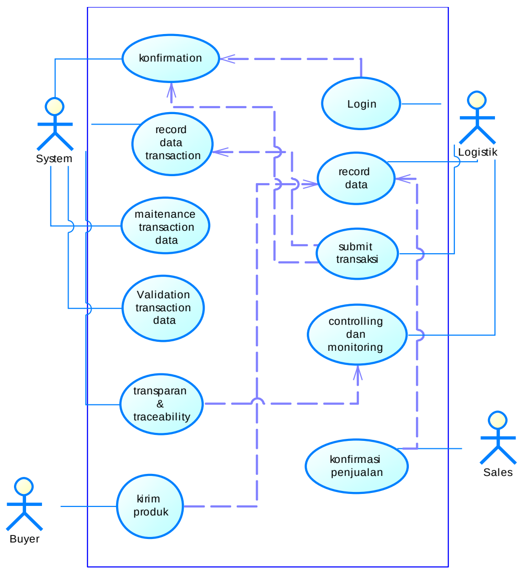


Fig. 4. Product return use case

Figure 4 explains the use case diagram regarding what can return sugar products to add and confirm transaction information, validation, and transparency and traceability of data transactions. The criteria that have successfully supply chain is transparency among actors [26]. According to in his paper, accurate traceability is transparency between actors along the supply chain. Information is recorded, verified, and available to continuously monitor traceability [27].

In this analysis, we identify actors involved in sugar product returns, business process rules, and data flows that support the operation of an activity. BPMN was created using the Power Designer®

software version 16.6. Notation in BPMN comprises internal and external ecosystem boundaries and regulates activities there in [28].

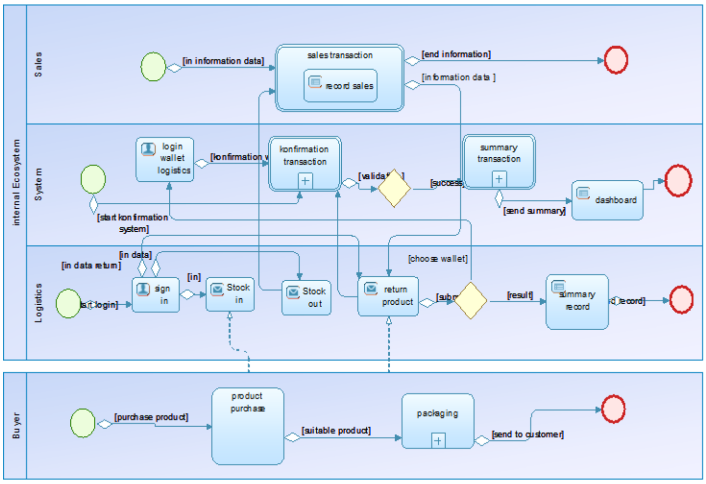


Fig. 5. BPMN Return of sugar products

In figure 5, the business process described consists of two internal for logistics: systems, and sales, while external is only for buyers outside the system, only transaction information for sugar product returns. Logistics will register at the beginning of the system to input product return data such as the date and buyer's name. Do number, the number of products returned, and the type of sugar returned.

After that, it will submit by selecting an available wallet because the logistics party chooses logistics. It will verify record data, and the blockchain smart contract validated. Implementation of the system will explain the system made based on the results of the design. To running a system, several stages must be done, such as making a web interface design and connecting the web with a database to display data.

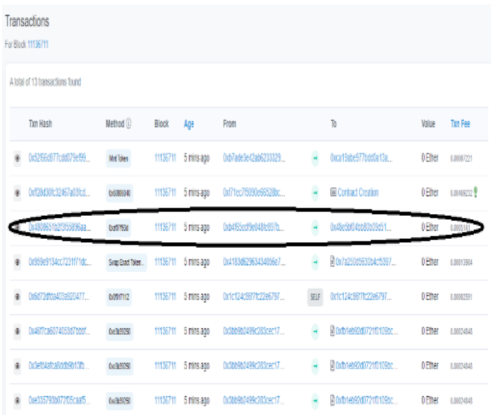
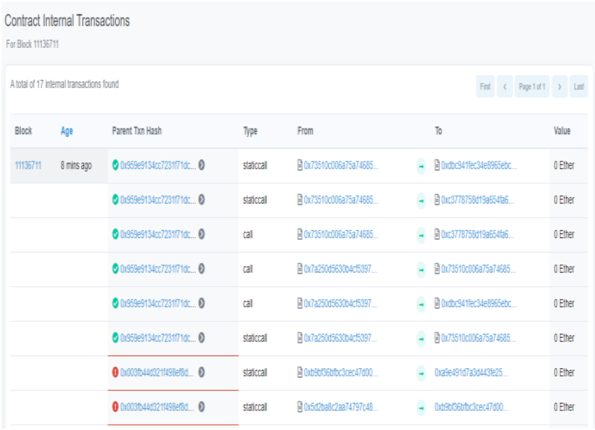


Fig. 6. Transaction display for block 11136711

Figure 6 is the transaction generated when the logistics user records transaction data hash 0x4808651b2f3f55896aa6w…, which comes from 0xb4f65edf9e048fe897, so that block 11136711 is generated with smart contract hash 0x48e5bf04bb80b096d51bd. Ethereum smart contract is a computer protocol that can create contracts digitally and written through program code. Smart contracts on Ethereum are written using solidity language.

 ISSN: 2579-7298


Contract Internal Transactions
For Block 11136711

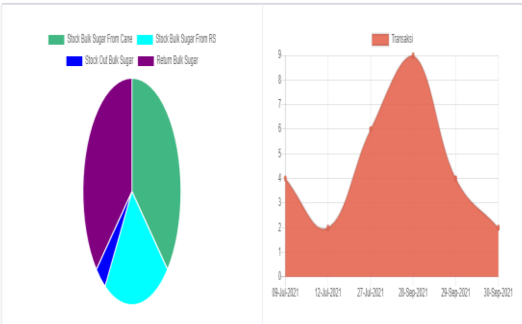
A total of 17 internal transactions found

First ‹ Page 1 of 1 › Last

Block	Age	Parent Txn Hash	Type	From		To	Value
11136711	8 mins ago	0x959e9134cc7231f71dc...	staticcall	0x73510c006a75a74685...	→	0xdbc941fec34e8965ebc...	0 Ether
		0x959e9134cc7231f71dc...	staticcall	0x73510c006a75a74685...	→	0xc3778758d19a654fa6...	0 Ether
		0x959e9134cc7231f71dc...	call	0x73510c006a75a74685...	→	0xc3778758d19a654fa6...	0 Ether
		0x959e9134cc7231f71dc...	call	0x7a250d5630b4cf5397...	→	0x73510c006a75a74685...	0 Ether
		0x959e9134cc7231f71dc...	call	0x7a250d5630b4cf5397...	→	0xdbc941fec34e8965ebc...	0 Ether
		0x959e9134cc7231f71dc...	staticcall	0x7a250d5630b4cf5397...	→	0x73510c006a75a74685...	0 Ether
		0x003fb44d321f498ef8d...	staticcall	0xb9bf36bfbc3cec47d00...	→	0xa9e491d7a3d443fe25...	0 Ether
		0x003fb44d321f498ef8d...	staticcall	0x5d2ba8c2aa74797c48...	→	0xb9bf36bfbc3cec47d00...	0 Ether

Fig. 7. Display of internal transaction contracts

Figure 7 is a display of the transaction contract that occurred in block 11136711 via Etherscan. The information shown by the smart contract is information related to the transaction hash, the block number formed, the time of the transaction.



User	Wallet	transaksi	transaksi Hash	
Logistics	0xb4f65edf9e048fe897b4a83d524935abf99222d7	Stock Bulk Sugar From Cane	0x4808651b2f3f55896aa6e0fc683a0118a251ec7df59c21dfcf7094f41317318a	transaksi wallet
Logistics	0xb4f65edf9e048fe897b4a83d524935abf99222d7	Return Bulk Sugar	0x4afdb00a09efce2f96d772942fe72237e5206cc8622175f114159bd6e673fbe1	transaksi wallet
Logistics	0xac76789bf2bc33ee4079e167db78bf4a500e2875	Stock Bulk Sugar From RS	0x3214b15febad0bac5602e006cec8eb602c0def79c43ee781a4a3d7615577e445	transaksi wallet
Logistics	0xac76789bf2bc33ee4079e167db78bf4a500e2875	Return Bulk Sugar	0x23a91d442739f6b58e38514d223a1dd8bd6d8f434fa88056c1f1da72415be605	transaksi wallet
Production	0x5313ed850c496bc4f2e08ffb4e766888bf67c329	Stock Bulk Sugar From Cane	0xe20c153cce50e770bec50cf9a3a926113154e7957e2abd6d10f31c1167a46654	transaksi wallet
Production	0x5313ed850c496bc4f2e08ffb4e766888bf67c329	Stock Bulk Sugar From RS	0x81465cdfe89393155ca58075769718b41446a49938713b2ae24d335f24500545	transaksi wallet
Admin	0x5313ed850c496bc4f2e08ffb4e766888bf67c329	Stock Bulk Sugar From RS	0xcfb125bf408ef22312f85fd301dab009d647aa724a6aaca03a2ca2303a2de618	transaksi wallet

Fig. 8. Blockchain-based sugar product return dashboard

The blockchain built is semi-public on the Ropsten Metamask Platform. All data transactions can be seen transparency by miners. Still, the smart contracts are designed only to be seen by internal parties, namely actors determined in the supply chain allowed by the system permission. All transaction data that has been entered cannot be changed or falsified. There is no prohibition against participating in mining transactions in a decentralized network.

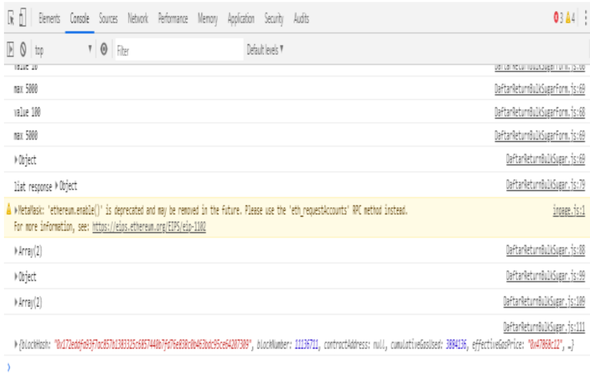


Fig. 9. Validation of transaction data

Figure 9 explains that the triumphant return data transaction is entered into the blockchain through a logistics wallet with the Ropsten Metamask platform. The blockchain system always requires validation in every transaction or information that occurs. The validation process starts from the formation of a block containing a new transaction. The newly formed block has a hash, where the hash number is formed based on the hash contained in the valid transactions stored in the previous block. The two hash values are compared. If the values are the same, it is declared valid, and if the values are different, it will be considered invalid. The system will not process it.

app > LogisticReturnBulkSugar.php

```
<?php

namespace App;

use Illuminate\Database\Eloquent\Model;

class LogisticReturnBulkSugar extends Model
{
    //
}

```

Fig. 10. Display backend code

Figure 10 is the backend code that resides in the Application programming interface (API). Code is a communication between the client and the server in simplifying the implementation and maintenance of the software. So the development of the API allows us to use standard functions in interacting with the operating system.

Smart contracts with the help of automatic code execution are distributed and verified by network nodes in a decentralized blockchain network. Used to execute agreements made when conducting data transactions between more than one entity [29].

```
// post ke blockchain data return ke stock (stok menambah dari return)
if(values.sugar === 'cane'){
  const storageContractSBSFC = new web3.eth.Contract(AddStockCane, contractAddressSBSFC);
  const gasSBSFC = await storageContractSBSFC.methods.addLogisticsSbsfc(response.data.stock.id, res
  var postSBSFC = await storageContractSBSFC.methods.addLogisticsSbsfc(response.data.stock.id, resp
    from: akun,
    gasSBSFC,
  }, (error, transactionHash) => {
    console.log([error, transactionHash]);
  });
  console.log(postSBSFC);

  // simpan hash
  const txnCane = new FormData();
  txnCane.append('id', response.data.data.id);
  txnCane.append('transaction', postSBSFC.transactionHash);
  txnCane.append('wallet', postSBSFC.from);
  txnCane.append('flag', 'stockBulkSugarFromCane');
  UserService.addLogisticsTransactionHash(txnCane);
} else {
  const storageContractSBSFRS = new web3.eth.Contract(AddStockRS, contractAddressSBSFRS);
  const gasSBSFRS = await storageContractSBSFRS.methods.addLogisticsSbsfrs(response.data.stock.id,
  var postSBSFRS = await storageContractSBSFRS.methods.addLogisticsSbsfrs(response.data.stock.id, r
    from: akun,
    gasSBSFRS,
  }, (error, transactionHash) => {
    console.log([error, transactionHash]);
```

Fig. 11. Smart contract code display

Figure 11 is the result displayed by visual studio code, which provides the code quote feature on the GitHub repository [30]. Visual studio code is built using server software platforms and network applications (Node.js web application) [31]. Up and Running with Node.js, and chromium web browser desktop-based application framework with HTTP, PHP, java script programming tools [32,33]. At this stage is a test of the results of the system that has been made previously. The test method is to experiment with the whole system of application functions. This test is carried out with several trials based on different cases and inputs. Initial testing is carried out for users who have not signed in to order a product or start a transaction. The system will give rights, To the user if he has signed in first. If you have not signed in, the system will provide feedback in an alert to the user to sign in first.

IV. Conclusion

Analysis of supply chain business processes specifically for sugar return products, for the type of sugar that comes from sugar cane and sugar. That comes from raw sugar shows that there are 2 actors, namely logistics and sales, added a system designed and external actors of the ecosystem, namely buyers. The feature of the public blockchain has been successfully developed. The transparency of data transactions is to track processes. That occurs throughout the system with a hash code to ensure the security and immutability of data transaction history. Privately designed smart contracts can be implemented and generate a hash code, which only internal factory actors can see. System testing is carried out based on a consortium of actors participating in the block; verification and validation are carried out directly to state that the transaction is successful (proof of work). Further research suggests the need for broader system implementation for several sugar factories. So that data transparency and accuracy can be monitored by stakeholders such as consumers, associations, and governments.

Acknowledgment

The authors want to thank for anonymous referees to give constructive feedback. The authors also thank to all persons who have supported this research and cannot be mentioned one by one. This research is supported by the Indonesia Endowment Fund for Education (BUDI-LPDP Indonesia).

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