Design of Intelligent Decision Support System for Sugar Cane Supply Chains Based on Blockchain Technology

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***Abstract*—The design phase usually starts from the process of identifying important variables to solve problems so that they can develop decisions and be used for evaluation and exploration of decisions. IDSS will produce a platform, prototype, or decision making model by adding someone's expertise to a computer with definite outputs. The complexity of the sugar supply chain system derived from sugar cane requires managers to consider the interrelation of the decision support system (DSS) of various factors on the sustainability of the sugar cane supply chain. In the supply chain, sugar agroindustry is currently using a centralized information system with a conventional database. So that the data stored can still be manipulated with a high level of mistrust between supply chain actors. Another problem is the loss of information in the supply chain network as well as incomplete obstacles in the data held by the chain actors, making it difficult to trace the supply chain and collect data information, products and financial flows in real time. Therefore, the proposed IDSS design on blockchain sugar supply based on blockchain technology.**

Index Terms*—Agroindustri Sugar, Blockchain, IDSS, Supply Chain

I. Introduction

Interaction of business actors in ecosystems is the basic process of decision making according to structured, semi-structured and unstructured categories. In the design phase usually starts from the process of identifying important variables to solve problems so that they can develop decisions and be used for evaluation and exploration of decisions [1]. Decision Support System that is made smart or intelligent by adding a knowledge base component as a decision support system for intelligent decision support systems [2]. IDSS will produce a platform, prototype, or decision making model by adding someone's expertise to a computer with definite outputs.

Indonesia as an agrarian country faces the challenges of national development in terms of economic, social and environmental. BPS data states the number of workers, which almost 30% are workers in the agricultural sector. Weak infrastructure in the business and supply chain, namely the number of activities and actors in the network both in terms of industry and government, causing uncertainties in demand, lead time, inventory, quality and price [3], [4]. One example of the industry that will be discussed in this study is the sugar industry.

Sugar in circulation in Indonesia can be divided into three types, namely raw sugar, white crystal sugar and refined crystal sugar. White crystal sugar is consumed in general by the people produced by sugar factories from sugar cane. In the sugar industry, the mill will plan production based on the maximum operating capacity and the amount of supply of sugar cane farmers throughout the cutting and milling season [5].

The problem of sugar is in terms of productivity based on traceability it is known that plantation productivity is determined by soil fertility, irrigation systems and the discrepancy between sugarcane varieties and available agricultural locations and weather factors at planting and harvesting (on farm) as well as at low yield levels. Because based on USDA 2017 data, the yield of sugar mills and sugar mill in Indonesia is only 7.5 percent. The decrease in yield cannot be separated from the age of the sugar cane mill which is 100 years old or more. The yield value is also influenced by the quality of sugarcane and the cutting time and quality of the mill machinery [5], (off farm). In addition, the high rate of sugar imports in Indonesia has made the government regulate the trade of sugar commodities by forming and implementing sugar commodity trading policies to protect domestic sugar factories, sugar cane farmers, increase the productivity of sugar cane and sugar mills in Indonesia which will have a positive impact on the Indonesian economy. The policy or

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regulation used to protect domestic sugar producers is the sugar import tariff policy. This policy aims to maintain the availability of sugar and the stability of a fair price so that it does not harm domestic sugar producers because it loses in terms of production costs but also pays attention to the purchasing power of consumers so that sugar consumers do not feel disadvantaged either.

The supply chain contains all the links involved such as information flow, product or commodity flow and also financial flow. The length of the process that a commodity has to go through to become a ready-to-consume product for consumers to the dining table, and it takes the right time in shipping commodities for processing to the distribution of finished products, the potential involves many stages and distribution locations based on dozens of geographical locations, causing difficulties in tracing the events that occur in supply chain activity [6]. The loss of information in the supply chain network as well as incomplete obstacles in the data held by the chain performer make it difficult to trace the supply chain and collect information, product and financial flow data [7]. Besides coordination and integration [8] between chains starting from farmers, processing factories, distributors, retailers and consumers to achieve an efficient and effective level of performance [4].

Previous research Purwandoko [9] designed an intelligent IT-based traceability system in rice agroindustry using data flow diagrams (DFD) based on information systems architecture. Whereas the sugar agroindustry in Thailand is in a competitive business environment according to Chiadamrong (2008) [10] focusing on warehouse distribution and management problems which are resolved based on decision making support with GA. Lejars (2008) [11] revealed that the assessment of farmers' sugar cane payment systems and profit sharing among supply chain actors can increase transparency based on a decision support system namely PEMPA.

The complexity of the supply chain system of sugar derived from sugar cane requires managers to consider the interrelation of decision support systems (DSS) [12] various factors on the sustainability of the sugar cane supply chain. Therefore, the proposed IDSS design in blockchain technology based on blockchain sugar as one of the fundamental techniques in a decentralized network. Works with many potential benefits, which have a distributed character. decentralized [13]. Potential benefits for supply chains are provided by blockchain as information technology [14], [15]. The consensus mechanism that cannot be changed and tampered with is useful for solving the general ledger problems that are distributed into supply chain actors.

II. Problem Description

The complexity of the sugar industry problems both in quality and quantity, the length of the chain from upstream to downstream, the number of actors who play in the supply chain with third parties or the ruling businessman (kertel), the lack of transparency and fairness of the data and results obtained between actors resulting in gaps and injustice occurs upstream of the chain, whereas in the downstream chain the end consumer only understands that the product consumed is in terms of its taste and crystal form only.

The foregoing results in actors who play a role upstream to switch roles to other commodities that are more beneficial both in terms of farmers and laborers, such as agricultural crops. The availability and price of sugar which is always fluctuating is added again as more and more imported sugar is converted into consumption sugar due to the lack of sugar cane produced so that the sugar factory is difficult to meet the consumption needs of the people. Lack of trust between supply chain actors is exemplified by farmers who lack trust with yields calculated by sugar mills and payment of yields that are not real time, and distributed data is still centralized and tends to manual recording.

Therefore, this research proposes an intelligent decision-making design by utilizing artificial intelligent techniques based on big data and real time data by utilizing new technologies such as the blockchain that applies smart contracts.

III. Research Methodology

The corresponding system framework and architecture consists of four layers based on different functions. "Fig. 1" explains that the lowest layer is the IoT sensor layer which works based on a digital information system, including utilizing IoT, such as web base applications, RFID, sensors, GPS, Barcodes and other 4.0 supporting technologies [17], [18] .

In the next layer will translate the desires of the supply chain actors with decentralization based on the distribution of ledger from blockchain technology. The data will be distributed from the beginning of the farmers supply chain until the product is consumed by the final consumer, such as data on the identity of the farmer, the location of sugarcane planting, the time of distribution of sugarcane from the land to the milling, milling time, packaging time in the warehouse until the sugar products are distributed to distributors and also retailers. So that the final consumer if you want to know the quantity and quality of sugar consumed can track up to the farmers, and farmers know in which locations the sugar cane planted is consumed by the community. In addition, transparency can be realized with the principle of peer to peer between actors in the supply chain network.

Blockchain-based platform design will produce quality data, logistics data, asset data and transaction data, so that smart contracts will be proposed for an agreement between two supply chain actors who transact such as sugar mills with distributors regarding the amount of sugar, quality and selling price of sugar, while from the parties farmers with the mill for the problem of sugarcane sharing where there is a provision of 66% for farmers who manage the land and the remaining 34% is part of the sugar factory which owns the land.

Next is the contract layer on the blockchain as the intelligence layer. Decision makers will solve business problem decisions between supply chain actors. Information between actors is collected and analyzed to help control the quality

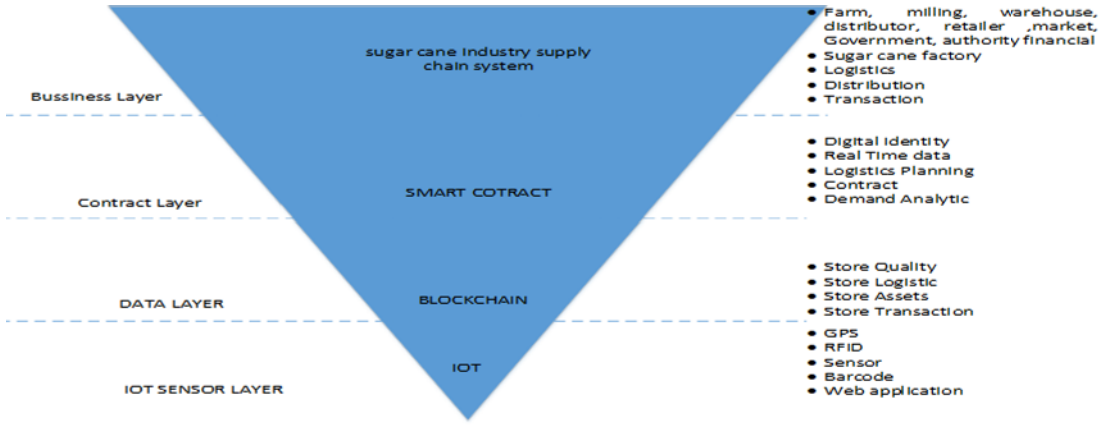

Fig. 1. Frame work Technology Blockchain (adapted from chen et al 2017)

and quantity of distributed data so as to improve efficiency in the supply chain.

The first layer that was formed was to determine what system would be discussed by identifying problems, the actors involved in this research were the sugar agroindustry supply chain system, which was more focused on community consumption sugar, which is derived from the commodity of sugar cane.

IV. Result and Analysis

Historical data retrieval comes from internal and external sources to be separated in stages of the data that will be used as information on the next layer in the decision making process intelligently. The intelligence design of the sugar agroindustry will help supply chain actors make decisions that are fast, real time and on target, by developing blockchain-based decision making that has decentralized, transparency, trustworthy and immutability characteristics, so that it is expected to be applied to complex supply chain systems and integrated. The complexity of the system and the length of the sugar supply chain make the ideal use case for the adoption of the blockchain and bring transparency and efficiency to the system.

Transparency is an important feature in traceability that is currently highly desired by consumers of food products. In this study, we consider that the flow and openness of information determine the success of decision making based on IDSS. Based on the type of distributed data information, we identify the supply chain system for sugar agroindustry as shown in "Fig. 2". Starting from information on data from farmers to data in retailers that will be uploaded in a web base application and can be read or checked by final consumers regarding quality and quantity of products. In addition, information flow can be used as a monitoring tool for the sustainability of the supply chain of sugar based on the social, financial and environmental aspects of the supply chain involved. Information delivered in the supply chain, to product movement from upstream to downstream based on needs and data transformation.

Blockchain has introduced its potential to bring positive change in many industries and businesses to date and the future design of the sugar supply chain industry. Agroindustry companies are currently looking for ways to design supply chain systems in maintaining coordination, reliable communication integration, transparency, fairness and synergy between farmers, sugar mills, retailers distributors to consumers, so that they can perform efficiently and adapt to changes offered to the industry 4.0 one of which is blockchain technology.

In fact, supply chain management is one of the most clear and useful applications of Blockchain technology, therefore, we can expect it to grow at a very fast pace in the near future. The source of the successful operation of the supply chain management system is to maintain strong, transparent, and synergy communication from farmers to consumers.

Agroindustry companies are currently looking for ways to design their supply chains to work and adopt the changes offered by blockchain technology. As illustrated below. With blockchain technology. We discard the document and replace it with a centralized database that will bring effective changes with optimal benefits and improved performance among the team or stakeholders in the supply chain. This can be achieved if and only if the supply chain team pays attention to the latest technology trends in the blockchain space and finds a feasible way to adopt technology in their existing systems. The use of blockchain in supply chain management will function as a game modifier by removing vulnerabilities and inefficiencies in the current system.

In "Fig. 2" which was adopted as Salah (2019) [19] that the design formed on the blockchain platform is a computational engine that collects, validates and executes transactions. In addition, the data of the transaction is stored in the big book which is replicated and synchronized by all miner nodes. To enable each entity or supply chain participant to participate in supervising, tracking and giving warnings when there are errors or differences in data between blocks. Each entity is a picture of the actors involved in the sugar agroindustry supply chain who play, participate and interact in the peer to peer blockchain chain. Among others are farmers, sugar factories,

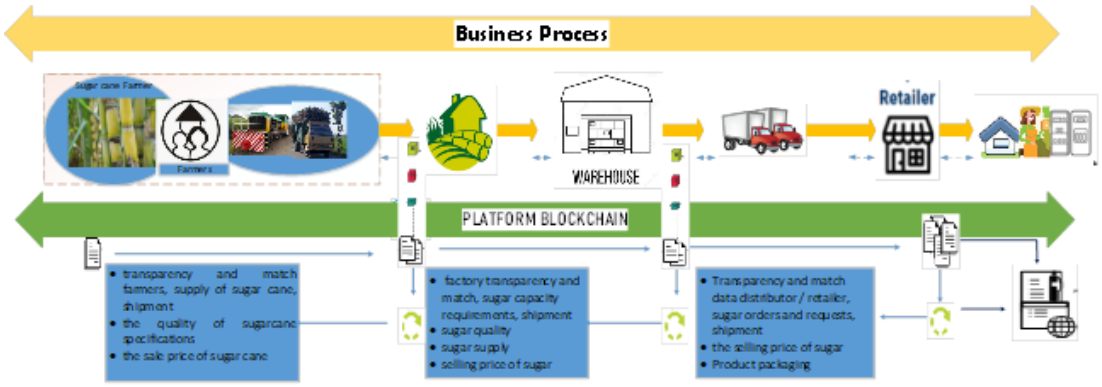

Fig. 2. Supply Chain Identification

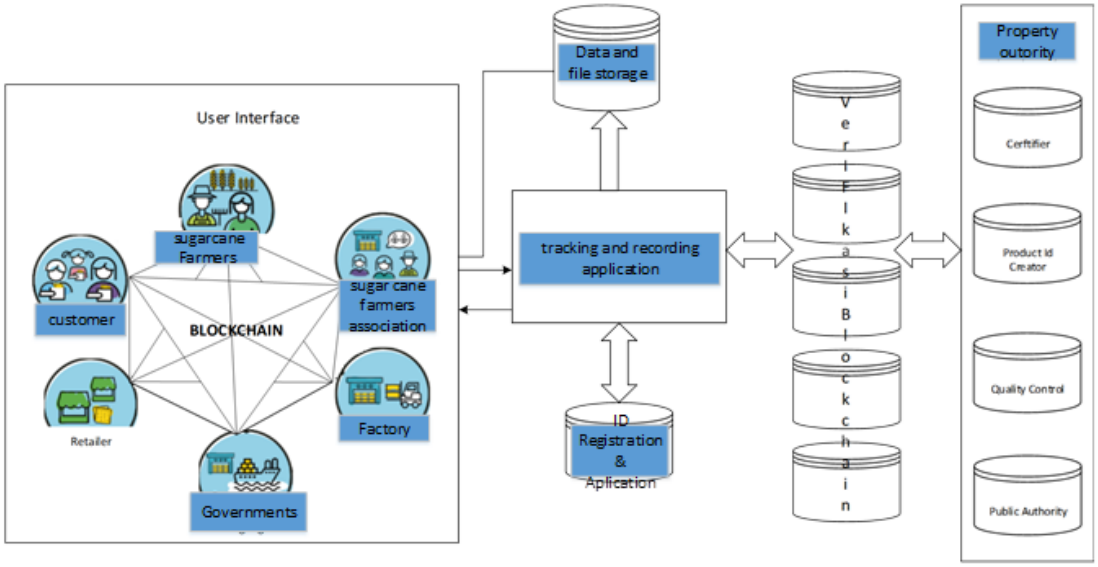

Fig. 3. Design Frame work IDSS for Blockchain Technology In Sugar Cane Supply Chain

warehouses, distribution, retailers to end consumers. And each farmer joins a farmer group, adding the association and the role of the government as supervisors and regulators.

"Fig. 3", adapted from Abeyratne (2016) [16] , explains a blockchain-based decentralized IDSS design to collect, store and manage the flow of information transactions on quantity and quality of products throughout the ecosystem involved. This will create a design framework that is safe to share with all actors in the sugar agroindustry supply chain according to their respective roles. It is planned that the finished products that are attached or will be distributed will be equipped with information tags in the form of barcodes, QR codes or web applications in order to represent digital identification in the blockchain network. And actors also must have a digital identity to facilitate search in case of information jams.

V. Conclusion

The proposed intelligent decision support system (IDSS) design is to utilize blockchain technology that has several advantages such as minimizing errors, supply chain performance being more efficient, increasing consumer confidence and all actors who play a role in the supply chain of sugar agroindustry. The system developed is based on a website that can provide information from upstream to downstream to facilitate supply chain transparency. Blockchain technology has the potential to improve agroindustry supply chains today, not only can improve performance in the flow of commodities, products and information and finance but can reduce the risks that occur. With the blockchain visibility, transparency and openness of transactions can go according to the wishes of each actor in the supply chain, with smart contracts, IoT can achieve efficient performance in the supply chain.

It is hoped that the IDSS framework can be applied by designing prototypes through platforms available for blockchain

technology. And can be implemented in sugar agroindustry. Although as a new technology that still requires a lot of financial capital and resources such as operators and technology.

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