Smart Agriculture Using Supply Chain Management Based On Hyperledger Blockchain

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Abstract. Indonesia is an agricultural country, and one of the regions is Semarang Regency which well known as chili producers. Unfortunately, common issues occurred such as the fluctuation of the stock price and chili, the low exchange values of farmers in prices because of the complicated flow distribution chain. Furthermore, chili is quickly decomposed, but the demand is high enough. The solutions are to predict the demand for supply chain management, to make payment transactions of agricultural needs of farmers by analyzing stocks, raw materials, price to the chain of distribution, also to build trade links among farmers, consumers and Semarang District Agriculture Service. This journal discussed the flow of supply chain and logistics. We recommend to use the latest technology called Hyperledger Blockchain and IOT so that they can make it easier to carry out the transaction process because it is simple, low cost, transparent, faster. It also has high data security, and simplify ecosystems can be easy to exchange information quickly through Hyperledger Blockchain transactions so that the potential of this technology can bring benefits to farmers and consumers by creating the construction of a trusted distribution network that will bring a data transparency solution so that it can become a suggestion for the Semarang District Agriculture Service.

1. Introduction

Hyperledger Blockchain and Smart contract technology provide many opportunities to produce efficient transactions, data transparency, easy data traceability so that it can produce transparent, fast, and cheap information, and the process does not meet third parties. Hyperledger Blockchain simply conveys information from related parties to another automatically, trusted and safe. Each transaction is made in a block, which will be verified by related parties to other Hyperledger Blockchain in one chain. This is also supported by the presence of digital and cryptographic records. \cite{1, 2, 3} Examples of Hyperledger Blockchain Application in Agriculture are without Blockchain the transaction process is still traditional and involves many collectors in marketing agricultural products when Hyperledger Blockchain is applied, it can break the ecosystem chain of collectors and traders, the consumer can recognize the place of production, they can even know when the crop is harvested and when the expiration date of the chili will be. \cite{4, 5, 6} From the survey results and interviews conducted at the Semarang Regency Agriculture Office regarding agricultural products, especially chili plants, the
finding can be illustrated through the following figure. **Figure 1.** is the distribution channel through several collectors and traders.

![Chili Supply Chain Flow in Semarang Regency](image)

**Figure 1.** Chili Supply Chain Flow in Semarang Regency

From several related studies regarding Blockchain conducted by Kim, et al on Blockchain and IoT, the technology can provide data security and fraud reduction since every ongoing transaction requires verification from all parties involved in one block. It often happens that diseases transmitted through food caused by cross-border trade are difficult to track, but by using the Blockchain it can identify hazards and information on the stuff which is not good. Equipped with monitoring features of land sensors, satellites, and drones thus improve the quality of plants, soil and reduce waste throughout the food chain. [7]. Further research tells the process of making Blockchains for supply chains in using distributed ledgers, the benefits of Blockchains and how Blockchains work in each transparency and easy traceability of information in goods and data transactions, and also financial resources. Kim, and Laskowski [8] At any related party transactions, each signed a digital contract that can be verified by all parties in a single block, thus allowing the system to identify fraudulent transactions or wrong in reducing transaction misplacement of goods. In its development, it needs infrastructure technology that can be updated continuously or automatically, such as RFID [9]. Research conducted by Tian in China concerning traceability of agricultural food supply chains using data collection RFID and Blockchain technology on food safety issues in traditional agriculture requires traceability of agricultural and food supply chains, identifying traceability of plant supply chains and food security by collecting, transferring and sharing authentic data on agricultural food in production, processing, warehousing, distributing, and sales links used for the safety of defective products, ensuring product freshness, transparency of information, increasing consumer confidence in clear products. [10]

In several related studies [7, 8, 9, 10] this journal literature will discuss agricultural issues in Semarang Regency and continue to discuss supply chains in using hyperledger Blockchain technology in Semarang Regency, Indonesia. Furthermore, it will be illustrated in the supply chain flow diagram in Semarang Regency and will be described in the framework of hyperledger Blockchain technology in agriculture, the technology hopefully can solve current agricultural problems and explain the role of hyperledger Blockchain technology to increase consumer confidence and welfare of farmers by adopting hyperledger Blockchain technology.
2. Method

Figure 2. below is a Map of Chili Production in Semarang Regency, the green color tells the region which produces a lot of chilies and the yellow color for the area that produces less chili.

![Map of Chili Production in Semarang Regency](image)

Hyperledger Blockchain for Tracking Information Stock, Price, Quality of Chili using RFID: In every transaction process in hyperledger block, it can store a lot of transaction data, the data can be processed into information in making a decision for example transactions carried out by the Blockchain. In agriculture there are several transactions carried out including payment transactions, the stock sold data, the name of the farmer, the price which comes from the farmer, the quality of the chili, the date of harvest, the date of chili delivery, etc. Those data are stored in an RFID database. From the data stored in the hyperledger block, the traceability of the data is tracked. Such data in the future can certainly be tracked and used as decision making by developing artificial intelligence so that it can produce predictions of how much will be needed in the future of chili-based on data that has been collected. [11, 12, 13]

Hyperledger Blockchain in Supply Chain Management to determine the planting time is based on market demand, weather, water content and soil using IOT sensor: Hyperledger Blockchain can transact without using a third party, but hyperledger Blockchain can be used to determine the period time of the chili crop based on market needs. This is obtained from the data traceability information above, using the IOT Sensor farmers can save planting time and harvest time based on the weather that changes very frequently, water content, soil content, etc. the data is stored from farmers and verified by consumers. [14]

Hyperledger Blockchain monitors the condition of chili through the process of observation, IoT sensor and Sensor Clarifruit on the quality of chili: With the seasons that change frequently at this time, Indonesia is included in the tropical climate but the weather can not be predicted based on time, causing a lot of droughts, water deficiency and dry, thus causing easy rot. Chili can only last 3 days if it is not using special care. Therefore we need a sensor that can check the condition of the chili, and using the Clarifruit sensor can automatically use a scan to detect plant rot based on color, aroma, temperature so that the quality of the chili can be maintained well and the expiration date can be seen from the date of harvest and filtering the condition of the chili. The data will be stored in Hyperledger Blockchain. [15]

Hyperledger Blockchain on the shortest distance logistics route for the efficiency of payment applies Google Maps: In the future, each transaction process using hyperledger block
requires efficiency, in this case, it can be applied to determine the distance of the shortest route to create efficient distribution in the delivery of chili so that it can provide a better profit. [16,17]

Hyperledger Blockchain In the distribution process for determining selling prices and profits based on the location of consumers uses Google Maps: The application of Hyperledger Blockchain in the chili distribution process affects the selling price; this process depends on the location distance between consumers and farmers, thus affecting the selling price on the market. To determine the price based on longitude and latitude point is using google maps. The data will be stored in the hyperledger Blockchain database and prices will appear every time a transaction is made. [18, 19, 20]

Hyperledger Blockchain for making sales price decisions is based on production quality and stock using RFID: The application of hyperledger Blockchain to make decisions in selling prices sometimes makes farmers feel difficult in determining prices, by using hyperledger Blockchain it is needed a grouping based on existing quality. For example, quality No. 1, 2, 3 and stock available in warehouses using RFID sensors that will be used to store data will be grouped together to produce a good selling price and the data is stored on hyperledger Blockchain. As a result, the data can be easily traced based on the harvest date carried out by chili farmers. [20,21]

Hyperledger Blockchain on payments for farmers’ profits cuts the chain of collectors: Hyperledger Blockchain is expected to increase farmers’ profits, from previously having to pass 5 distribution channels, which are farmers, small collector, large collector, wholesalers in traditional markets, retail traders in traditional markets, consumer’s hands, can be cut directly from farmers to consumers in fact, this can cause changes in the ecosystem. On the other hand, every block transaction is not required to cost anything, so that it gives benefits to all parties. In each process, it requires verification from each block party. [22,23]

3. Result and Discussion

Based on the surveys and interviews conducted at the Semarang Regency Agriculture Office, the research was done by applying the following preparation:

**Tools and Materials**: RFID, Hyperledger Blockchain, Website, Maps.

**Place and date of study**: In the Semarang Regency Agriculture Office which situated at Putotan Sidomulyo, Ungaran Timur District, Semarang on September 13, 2019.

**Research steps**: Interview the Agriculture Office, Mrs. Retno Supatmi, SP as Head of Horticulture and Development.

**Smart Agriculture Process**: Analyzing Chili Problems, Providing Solutions with Supply Chain Management based Hyperledger Blockchain technology.

Regarding the distribution chain of chili plants from farmers to consumers, the following are the tasks of each Supply Chain Management:

**Data collection methods**: Our data was obtained from the Semarang District Agriculture Office.

**Farmers**: A party who produce chili, harvest and sell chili in quantities (kilograms) to small collectors.

**Small collector**: A party who works as chili collectors from farmers in a village, he usually uses pickup trucks to load the chili and then resell it to large collectors.

**Large collectors**: The party whose job is to buy chili from small collectors and resell to wholesalers using trucks to traditional markets.

**Wholesalers in Traditional Markets**: A party who buy chili from large collectors, which will be resold at traditional market retailers.

**Retailers in Traditional Markets**: Those who buy chili from wholesalers to sell retail to consumers.
Consumer: The party who buys chilies from a retail trader, which will be consumed or resold at the store.

The harvest time of chili plants is about 3 months or 4 times in a year and once the harvest is finished, the age of chili to be rotten is around 3 days (except ozonation process, which is the process of sterilization, removes heavy metals such as iron (Fe) and manganese (Mn) attached to food products which extends shelf life, and increases the level of food safety), automatically chili plants cannot be stockpiled. The chain involved takes a lot of time thus speeding up the decay process. From the price side, because it passes through many ecosystem chains, the price of chili increased very highly, and the quality was also questioned because it took too long to go through the process. We propose to break the supply chain management ecosystem by using the hyperledger block as follows: Farmers can sell directly to consumers, so it can maintain the freshness of chili and its prices will be stable as a result, it increased farmers' income, let us see the illustrated below in Figure 3.

**Figure 3. Proposed Flowchart of Chili Distribution Blockchain**

Data in the block in each transaction is divided into several parts of the block. The system where blockchain functions server as a database. Any valid transaction has been validated by a block regulated by the protocol. Each Blockchain block contains: Data (timestamp and transaction information), Hash (prints of encrypted mathematical transactions), Hash is the unique identifier of the block, and Hash from the previous block.[24] The picture is seen in Figure 4.

**Figure 4. Connecting blocks and checking hash functions**

Here is the Hyperledger Blockchain framework for Semarang Regency which focuses on the following Chili [25]. It can be seen in Figure. 5 and figure.6
Figure 5. Concept of Smart Agriculture with Hyperledger Blockchain

The picture above is a block Blockchain against data searches chili farmers. Harvest date and the expiration date are shown in the Figure. 5 and 6. Consumers can see where the chili comes from, and then farmers and the Semarang District Agriculture Office can also be viewed and verified chili until it handed to customer based on location, farmer name, harvest date, the expiration date of chili (Rotten) usually 3-4 days after harvest, delivery date, number of purchases (kg), type of chili, type of chili variety, price of chili, quality of chili. Every given product will be attached without information in the form of RFID. This tag represents a unique digital cryptographic identification that links to physical data to its virtual identity in the hyperledger block network. The Following are the actors involved in Hyperledger Blockchain.

Farmers : Those who produce chili harvest and sell chili in quantities (kilograms) to consumers.
Consumer : The party who buys chili from farmers, which will be consumed or resold.
Agriculture Office: Monitoring and Evaluation of Every Transaction of Chili Sales in Semarang Regency.

Here is the hyperledger Blockchain framework design in Figure 6 as follows:

Asset: Farmers and Consumers carry out the chili sales process, monitored and evaluated District Agriculture Office.

Participant: Farmer, Consumer, Regency Agriculture Service

Transaction: Traceability Information on Stock distribution, price, chili quality using RFID

Commodity: Harvest, Transaction Purchase

The following is a comparison between Blockchain with the Traditional Database, from all aspects in Table 1. Below:

| No. | Difference          | Blockchain                                                                 | Traditional Database                                                                 |
|-----|--------------------|-----------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
| 1.  | In terms of architecture | Blockchain users can maintain, monitor the count, enter new data into one database. All nodes work together to ensure they all arrive at the same thing as well as provide built-in security for the network. | Database users with permissions through their respective accounts can change whatever data has been entered. Even though database control remains with the administrator. |
| 2.  | Database Controls   | Transactions are processed by a user network that acts as a central controller, so everyone creates the same shared record system at the same time and can verify each other every transaction, it is safe because they can control each other. Blocking data also cannot be changed and deleted. | The database is controlled by the administrator only, so the database is only centralized in the administrator. |
| 3.  | the performance     | The recording system on the blockchain tends to be slow because it requires verification from all parties involved in the payment process. | The database is faster because it only passes through one administrator distribution. |
| 4.  | Confidentiality     | The blockchain database is centralized so that whatever the process is written, it is controlled by only authorized users who get permission to write and read the database. | Easily changed and controlled by the irresponsible. If it falls into the irresponsible, it will be easily controlled by exploiting the weaknesses of programming logic. |

4. Conclusion
In this paper, the researchers would like to suggest to the Semarang Regency Agriculture Office regarding traceability of supply chains in the Semarang Regency on Chili Plants Using Hyperledger Blockchain, RFID, IoT Sensor, and Maps. Each process consists of the transaction, verification, location traceability, farmer name, harvest date, the expiration date of chili (rot). The expiration date usually lasts 3-4 days after harvest. The delivery date, purchase amount (kg), type of chili, type of chili variant, chili price, quality of chili can be accessed and monitored by farmers, consumers and Agriculture Services of Semarang Regency so that the management of traceability, data security, the quality of chili can be trusted. Because each transaction did not involve a third party in the payment
process, each party can verify each transaction. In the future, hyperledger blockchain can be developed and implemented using Artificial Intelligence so that existing data and transactions can be predicted, classified and clustered based on the period. In the Blockchain, the evaluation process can be seen from the system of the relationship between the node and the block whether it is going well without interference and checking the previous hash value of the Blockchain and database.

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Acknowledgments
The author really appreciate the ITS Surabaya Supervisor who has provided guidance in conducting this research. Thanks to the Semarang University and the Ministry of Research and Technology that has supported my Doctoral Program in ITS. Thank you to the Semarang District Agriculture Office for providing information and support regarding this research.