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Designing Architecture Blockchain of Hyperledger Fabric for Purchasing Strategy

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ABSTRACT

Hyperledger Fabric refers to a blockchain technology regulated by the Linux Foundation, which implements a blockchain network, namely the permission blockchain. The network provides a membership service concept, which means that only certain parties can transact and access data. This research will show the blockchain architecture design of the hyperledger fabric, which is designed for the purchasing strategy of recycled waste products. The design will be used to make purchases for managing distributors in buying recycled waste products from waste banks as raw materials to be processed. The traditional purchasing process using the bank as a third party will take longer and will be more expensive. Therefore, this research aims to improve data security and transparency between the authorities and direct the payment process in an instant and dramatically reduce transaction costs. Besides, this design can also be applied to any e-commerce. The method used is blockchain, which focuses on hyperledger fabric design. The position on the hyperledger fabric is only applied to the transaction processing of the hyperledger fabric. This study's results apply a design to a blockchain system using a hyperledger fabric to overcome several technical problems related to blockchains such as throughput, scalability, and interoperability and contribute to purchasing strategies.

Keywords: ***Architecture, Blockchain, Hyperledger Fabric, Permissioned Blockchain, Purchasing.***

1. INTRODUCTION

Purchasing is part of the procurement process, which describes the activities and processes for obtaining goods and services. Purchasing activity includes requesting, approving, making purchase orders, and receiving goods [1]. Each company certainly has a different purchasing system. Technological developments have triggered companies to develop and expand their marketing by building e-commerce or buying existing e-commerce so that online payment mechanisms play an essential role because customers pay for goods and services online. Traditionally, the payment methods in most e-commerce are carried out conventionally, such as banknotes, checks, money orders, and banks, which have many limitations and barriers even though the speed of the transaction system is a critical requirement of the e-commerce purchasing process [2]. A transaction system using a bank as a third party requires reconciliation, which is expensive and time-consuming. For example, a company with 70 billion transactions and processes an average of 150 million transactions every day, with such a large volume, will have little opportunity for cost savings, even in the transaction cycle accompanied by clearing can take three days. Failure to reconcile transactions can result in significant monetary losses. By blockchain technology, the transaction process will lead to instant payment processing and will dramatically reduce transaction costs [3]. Previous research has discussed blockchain technology, which will be explained in detail in section 2 regarding previous research. Results of a review of several previous studies related to the application of blockchain show that there are still technical problems that have not been resolved, such as throughput, scalability, and interoperability as well as overcoming the diffusion of blockchain technology, BPR (business process reengineering) and managerial implications and social impacts [4].

Overcome the technical problems above; this study will show the design of a blockchain system using hyperledger fabric for a strategy to purchase recycled waste products from waste banks to distributors as processors of recycled products. To increase the purchasing of managing distributors to waste banks. The purchasing strategy is created by designing a blockchain architecture from hyperledger fabric that can be applied to managing distributors and other e-commerce sites. The study method used in this research is a quantitative study, and one of the reasons for applying blockchain to the purchase of recycled waste products is because blockchain applications can promise several areas such as logistics, medical, insurance, and the public sector [4]. Waste management distributors and waste banks are industries that are included in the public sector area.

Blockchain is a technology that is currently widely used in various fields for data security and transparency. Blockchain is a transaction process that is carried out with a cryptography-based mechanism based on peer to peer, where each organization holds a digital database known as the ledger in the application. Blockchain transactions are stored chronologically using a timestamp or timestamp in each block. Each new block will be chained to the previous block. After a block is created in a blockchain, the transaction data cannot be tampered with or deleted. Therefore, the blockchain provides tamper-proof data which means it is computationally impossible to reverse the transaction [5].

Hyperledger Fabric is a blockchain technology that is regulated by the Linux Foundation, created to promote blockchain technology users to companies, especially for enterprise applications. The following are some of the goals of Hyperledger [6].

a. Rich Queries which means users can execute transactions executed on the blockchain platform.
b. Modular architecture, which means that various modules can be used either simultaneously or as needed.
c. Protection of digital keys and sensitive data means working on general ledger distribution concepts and protecting digital keys and data from tampering.
d. Permission data which means that only certain parties are allowed to be able to view and use specific data.

Although the blockchain architecture to be designed in this study focuses on the hyperledger fabric design, this research does not integrate existing hyperledger fabric platforms, but only adopts the transaction process of hyperledger fabric. Besides, this research also does not discuss the channel creation process, which means that the channel created between peer and client is dummy data and does not discuss in detail the process of invoking chaincode.

2. PREVIOUS RESEARCH

The following is previous research that can support this research which is based on one of the studies [4], In this study, there is approximately 106 literature using the SLR (systematic Literature Review) method to gain insight into correlated problems [4]. Research results show that the literature has been grouped into various topics and methods used in previous studies, as shown in the table below.

Table 1 Literature Topics and Methods Group

Topic/ Methods	Architecture Building and System design	Case Study	Algorithm & Protocol	Literature Review
Supply chain integration		[15]		[16]
Purchasing and supply		[14]		
Transaction Process	[7,8]		[9]	
Blockchain with other technology	[17]		[18]	
Traceability and Transparency	[10,11,12]		[13]	[14]

Table 1 shows research with the most frequently discussed topics and the less frequently discussed topics related to the use of blockchain in supply chain management. Topics and methods in table 1 are the results of the screening of the selected research [4] due to correlation and intersect with this research to look for opportunities in research renewal. These topics include transaction processing [7], [8], [9], traceability and transparency [10], [11], [7], [12], [13], purchasing and supply [14], supply chain integration [15], [16] and blockchain with other technologies [17], [18]. Results of the selected topics show that the most frequently discussed topics are traceability and transparency in each study using different research methods and objectives. The method in research [7], [10], [11], uses architecture building and system design. Research of [10] aims to track trade by increasing transparency in SCM by proposing blockchain and smart contract designs in the price tracking section of SCM. Then in research [7] proposed a blockchain design for gcoin intending to make drug transaction data transparent. While the literature on the topic of purchasing and supply is rarely discussed, there is only one literature that is discussed in research [4] using the case study method and the objective of evaluating designs for digitization interventions in purchasing and supply management (PSM) and identifying several principles basic design [14].

Based on previous research, the contribution in this study will discuss purchasing and supply with the architecture building and system design research method, but it does not discuss supply but only purchasing. Besides, this research will focus on the hyperledger fabric design, which will be illustrated in figure 1 for a purchasing strategy designed to solve blockchain technical problems.

3. METHODOLOGY

This section describes the scope of research that shows the focus of the study, explains the stages of blockchain and presents the design of the hyperledger fabric.

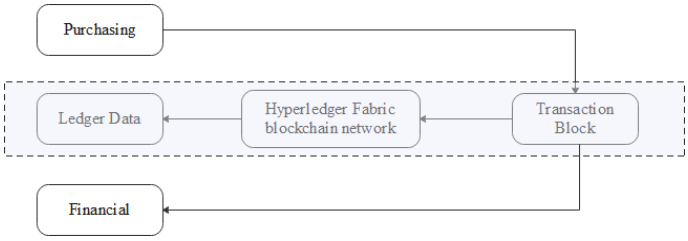

Figure 1 Scope of Research

Figure 1 illustrates the scope of the research; each buying process will continue to add blocks to the transaction chain or what is called a transaction block. Transaction blocks are one of the focuses of research coverage because basically, every transaction

will undoubtedly add a new block to the chain [5]. However, in this study, transaction blocks are not generally chained, which can be accessed by all parties, but chains will be added according to the channel ID designed in Hyperledger Fabric [6]. Then the next scope is the Hyperledger Fabric blockchain network, this section will explain the transaction process running on the hyperledger fabric, and the Hyperledger Fabric blockchain architecture design in detail described in Figures 4 and 5. Transaction data, data on blocks and channel data will all be updated in ledger. It becomes the focus of research because the data ledger will also be updated based on the channel ID. After updating the ledger data, the system will continue to process the payment that will be accepted by the client.

Blockchain is a collection of blocks that is entirely open for everyone. An important feature that needs to be known in the blockchain is that every data recorded in the ledger cannot be changed or deleted. Each block in the chain consists of specific data and a previous hash. Besides, each block also has a value that can be compared to a fingerprint. The hash of each block will change as the modifications are made to the block. Hence the hash value is an essential factor while making modifications. If there is a change in the hash value, it will not be considered the same block again. Besides, the hash of the new block will hold the hash of the previous block. It helps create chains by linking new blocks with previous blocks and is one of the block features that makes the blockchain secure [5].

In blockchain technology, there are several classifications of nodes that are used depending on the level of participation and the type of blockchain network. Each network has a role. The following is an explanation regarding the types of blockchain nodes [19].

a. Public blockchain nodes

A public blockchain is open to anyone who participates and the network functions, and there is no restrictive mechanism for accessing data.

b. Permissioned blockchain nodes

Permissioned blockchain is a private network that is used or can be combined on several blockchain technologies, but not all. In this node, not all parties have the authority to access data, but only those who are permitted.

These nodes are the nodes used for the Hyperledger fabric. The nodes in a Hyperledger fabric are called peer and orderer. Besides, the nodes in Hyperledger fabric are used as the ledger data host and ensure that the data is organized. Hosted data can include smart contracts, orders, policies, channels, application, organization, identity and membership. Another thing that distinguishes fabric from other technologies is that the fabric peer can accommodate more than one blockchain ledger. This feature makes it possible to flexibly design architectures on private blockchain systems.

Hyperledger fabric in this study will be designed according to the blockchain system used for the purchase strategy. In this study, the roles or users who will use the system include managing distributors as peers, waste banks as clients and purchasing systems for recycled waste products as applications that will be used by all parties involved. The following are the stages of the product purchase process that will be the design for the hyperledger fabric and this stage is depicted in Figure 5.

i) The client offers the product to the peer by sending a product offer proposal for purchase. The proposal contains product prices and policies that need to be agreed upon if the peer agrees to by product from the client.
ii) A peer will respond to the proposal. If approved, the system will create a channel between peer and client so that data can only be accessed and transparent to the organization that has agreed.
iii) A peer will continue to process the payment. The payment system will run according to the transaction module on the hyperledger fabric.
iv) When the payment process has been completed, the data will be updated on the ledger.

4. RESULT AND DISCUSSION

This section will explain the purchasing application framework concept, which is described in the figure below.

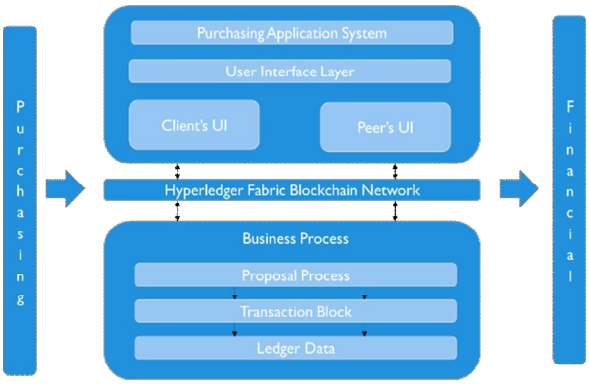

Figure 2 Purchasing Application Framework Concept

Figure 2 shows the process that begins with product purchases made by peers. The purchase process will run through the user interface provided by the system, namely the Client's UI and Peer UI. Every activity carried out through the user interface will go through the hyperledger fabric blockchain network which will be described and explained in figure 3. Then the network will carry out the business of the purchase transaction process described and described in Figure 4.

The client's UI is used by waste banks to offer product purchases to distributors, functions available on the user interface include making proposals, submitting proposals and digital signature proposals. While Peer's UI is used by managing distributors who

can receive offers from waste banks to buy recycled waste products, the functions available on the user interface include approving proposals and continuing payments.

Hyperledger fabric blockchain network will be described in detail in the figure below.

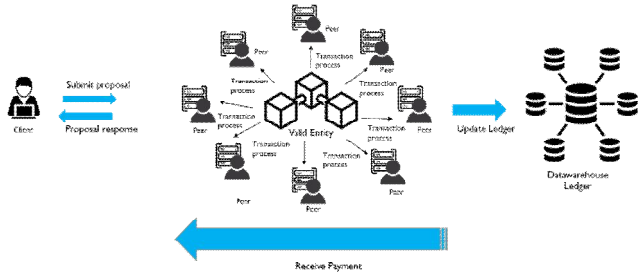

Figure 3 Hyperledger Fabric Process Details

Figure 3 has been explained in section 3 related to the design of the hyperledger fabric for use in the purchasing strategy in paragraph 5.

The business process briefly starts with the proposal process, transaction block and data ledger. For a detailed explanation regarding the business process, it will be described in the figure below.

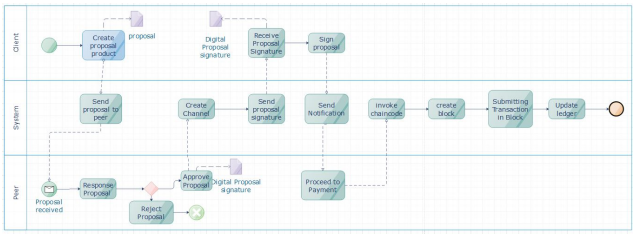

Figure 4 BPMN Purchasing Process

Figure 4 shows the purchasing process in detail designed with BPMN. Here is the explanation.

a. The client will make a product proposal for the peer.
b. The system will send the proposal to the peer.
c. The peer accepts the proposal. Then respond to the proposal.
d. If rejected, the peer can reject the proposal. Then the system will not continue the process.
e. If approved, the peer will approve the proposal with a digital signature.
f. The system will create a channel between the client and the peer. Then send the proposal back to the client.
g. Client accepts the proposal. Then sign the proposal with a digital signature.
h. The system sends a notification to the peer. Then the peer continues the payment process.
i. The system will start the purchase transaction process flow with the hyperledger fabric module, starting from the invoke chaincode to updating the ledger data.

Furthermore, the figure below will describe the blockchain architecture design of hyperledger fabric.

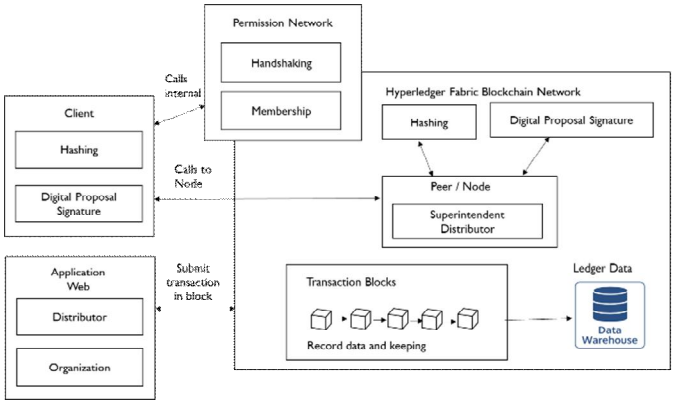

Figure 5 Architecture Blockchain of Hyperledger Fabric.

Figure 5 shows the architecture in detail regarding the hyperledger fabric blockchain network. The client will call the peer/node to sign a proposal with the applicable terms and conditions of purchase. The nodes used for the hyperledger fabric are network permissions wherein the network if the peer and client have agreed with each other, the system will "handshake" and will be linked with a membership so that the two parties can only access data. In hyperledger fabric node network, it will also perform a digital proposal signature for the peer to sign the proposal sent by the client. The web application runs the transaction process until the blockchain can add transaction data and when the transaction process is complete, the system will update the data on the ledger, the updated data is the block data and transaction data contained in the block.

Every time there is an agreement between the client and the peer, the system will always create a channel or membership by creating a new database so that it creates many new databases. It can solve technical problems in the throughput where data can be processed more quickly without the accumulation of data in one database, with the existence of a membership which makes data grouped based on Channel ID, so that interaction between clients and peers can be done without access restrictions and is safe from irresponsible parties. It can solve technical problems on interoperability where the client and peer can interact with the system without access restrictions both now and in the future.

5. CONCLUSION

Based on the design results that have been described in chapter 4 of the results and research, the results of this design can overcome several technical problems related to blockchains such as throughput and interoperability and contribute to purchasing strategies. It is necessary to pay attention to the speed in processing transaction data so that there is no accumulation of data because it takes a long time to process data. By membership system, the hyperledger fabric data will be processed based on the channel ID so that it can be carried out in parallel if the transaction processes from various peers can be carried out simultaneously, thereby reducing the risk of data accumulation due to delays due to unresolved transaction processes. Besides, Hyperledger Fabric system can interact between authorized parties and function as

needed without any access restrictions. It can solve interoperability problems on the blockchain.

Most of the previous research used blockchain for the primary purpose of transparency, security and traceability. Some studies design different architectures and systems according to the circumstances at hand and made with various methods that allow the researcher to solve the problem at hand and achieve the goals which the researcher wants. The same thing was done in research [10], but the difference lies in the blockchain approach used. In the research [10] using the ethereum network, which means using a public blockchain network, where all participants or application users can access data without being restricted. By using a public blockchain, all data can be verified and audited, so that all participants in the ecosystem can verify all information by consensus. It allows unauthorized parties to find out data that may not be needed by certain parties, even though the data has been encrypted. Whereas the use of hyperledger fabric in this study, data can only be accessed by parties who already have an agreement to make transactions. Therefore, blockchain design with hyperledger fabric can be used as a solution for classifying block transactions based on channel ID. However, some things need to be considered in implementing the hyperledger fabric design in the purchasing strategy, with the creation of a database that continues to grow as channels increase, it is necessary to ensure that the hardware/network used can accommodate data loads with larger volumes in the future. So, this research is not necessarily able to solve scalability problems on systems with hardware that have smaller capacities.

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