

BLOCK CHAIN TECHNOLOGY ARCHITECTURE FOR SUPPLY CHAIN TRACEABILITY OF FISHERIES PRODUCTS IN INDONESIA: FUTURE CHALLENGE

IRAWAN AFRIANTO^{1, 2, *}, TAUFIK DJATNA³, YANDRA ARKEMAN³,
IRMAN HERMADI², IMAS S. SITANGGANG²

¹Departement of Informatic Engineering, Universitas Komputer Indonesia,
Bandung 40123, Indonesia

²Departement of Computer Science, IPB University, Bogor 16680, Indonesia

³Departement of Agro-Industrial Technology, IPB University, Bogor 16680, Indonesia

*Corresponding Author: irawan.afrianto@email.unikom.ac.id

Abstract

The purpose of this study is to design a block chain technology architecture model with a product traceability mechanism to maintain the safety, quality, and consumer trust in the supply chain of capture fisheries products. The methods used in the research include data collection and analysis, identification of the current supply chain system and traceability mechanisms, developing a block chain-based fisheries supply chain traceability system architecture, and designing the smart contract mechanism in the developed system architecture. The results obtained from this study were a model of supply chain architecture for fisheries in Indonesia with traceability mechanisms and the use of smart contracts. The development of the results is expected to provide a comprehensive design of the application of block chain technology and its advantages. Furthermore, it also expected to increase product traceability, transparency, and trust in Indonesian fishery products. This is intended to maintain the quality and safety of perishable food products, especially capture fisheries products in Indonesia.

Keywords: Architecture, Block chain, Capture fisheries, Indonesia, Traceability, Smart contract, Supply chain.

1. Introduction

Block chain is a general ledger system that records every transaction in the form of a decentralized database network [1, 2]. This technology acts as a connector software in the environment with a higher level of security, more efficient, and more reliable [3, 4]. It consists of three core elements namely timestamp-based block chain structures, distributed storage mechanisms based on P2P networks, and consensus mechanisms based on decentralized nodes [5, 6].

There are no centralized or hierarchical structures in the block chain network [7]. Block chain is a decentralized system consisting of six layers: data, networks, consensus, contracts, services, and applications [8-10]. In addition, the development of block chain 2.0 technology has led to a smart contract technology that can be used to automate processes and keep assets safer [11].

Previous studies have shown that traceability has a very important role in maintaining transparency, quality, and safety of a food product [12]. The main purpose of the traceability system is to record products ranging from raw materials to consumers [13, 14]. In block chain-based supply chains, n order is used to maintain transparency and traceability of a product [15-20].

In China, a traceability model for agricultural products has been developed using RFID-based block chain and IoT technology [16]. Block chain technology is considered to have the ability to develop supply chain business models by reengineering traditional supply chains to be based on block chain [21], while the application of block chain-based logistics operations produces a system that is able to provide a faster and more accurate traceability model [22].

The application of smart contracts to traceability of food products will make it easier to maintain correct information because it is completed automatically [14]. Smart contracts are able to validate data automatically.

Therefore, if there is an error in the production process, it can be traced quickly [20]. Traceability system with guaranteed quality and safety of a product has an impact on increasing consumer trust [23].

The purpose of this research was to develop a capture fisheries supply chain traceability model in Indonesia by utilizing block chain technology and smart contracts. The research was started from the mechanism of data collection, analysis, and evaluation of the current conditions of Indonesian fisheries to provide a solution.

2. Methodology

This study used a descriptive analysis approach (See Fig. 1). The first stage is data collection. The second stage is to analyse and evaluate the condition of fisheries in Indonesia. The third stage is to design a traceability architectural model for fishery products based on block chain technology. The last step is to form a smart contract design that were used in the capture fisheries supply chain traceability system in Indonesia.

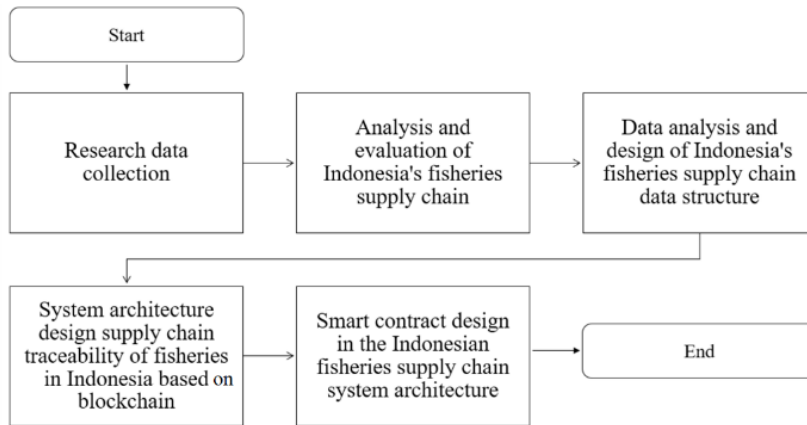


Fig. 1. Research methodology.

3. Results and Discussion

3.1. Case study and data analysis

The National Fish Logistics System is the policy of the Indonesian government in realizing national sovereignty, independence, and food security. This guarantees availability, affordability, and sustainability for the fulfilment of fish consumption and fish processing industry [18]. Distribution of capture fisheries products in Indonesia consists of several entities with their respective functions and roles (See Fig. 2). The distribution of capture fisheries products includes fishermen, fish auctions / fish markets (TPI / PPI), as well as large and small traders to consumers.

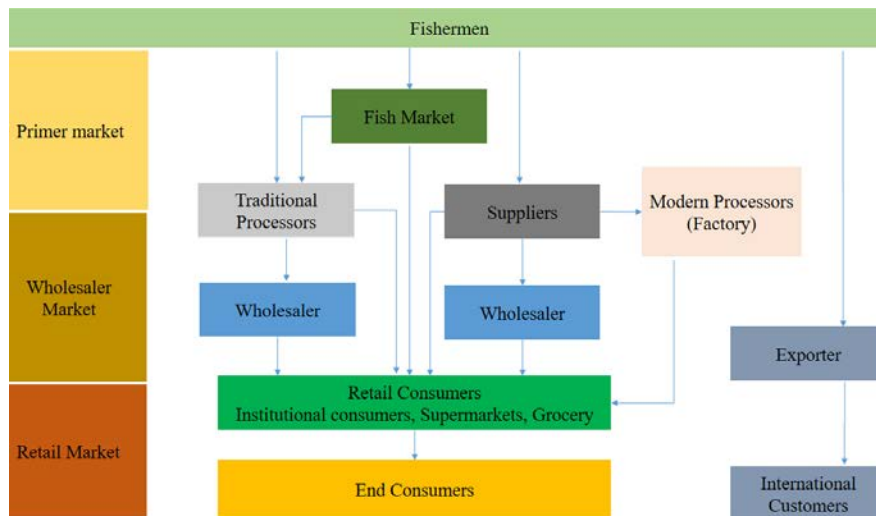


Fig. 2. Indonesia capture fisheries product distribution flow [19].

The traceability mechanism in the fishing supply chain in Indonesia can be considered as a process flow from upstream to downstream and data requests that flow from downstream to upstream (See Fig. 3). Data is streamed from fishing

entities to consumers, while the traceability process can be carried out by consumers to get information up to the fishermen entity.

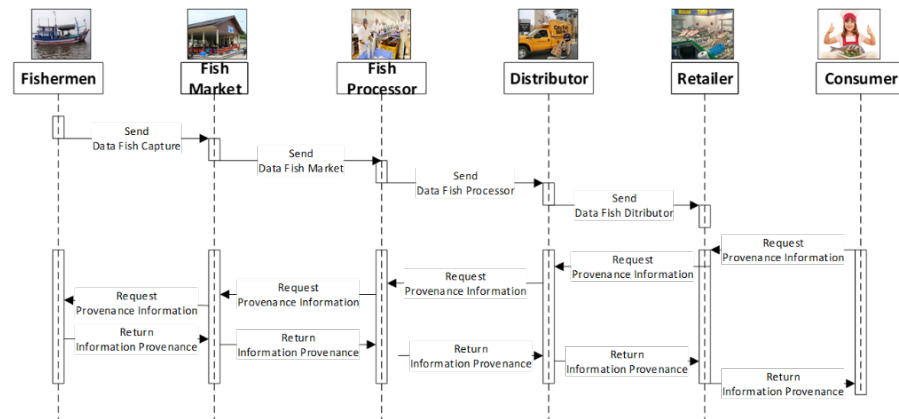


Fig. 3. Modified capture fisheries traceability flow [23].

The process of traceability of a capture fishery product started from the flow of data and information on the supply chain. The picture of the capture fisheries supply chain is shown in Fig. 4.



Fig. 4. Capture fisheries supply chain.

A block chain based information system process the data from fishery products supply chain. It is to maintain data traceability, transparency, and security. The data model for fishermen and fish market entities is shown in Table 1. The model represents data that is processed and managed by fishermen and the fish market. The data model contained in fish processing entities and distributors is shown in Table 2. This model is adjusted to the data which is processed and managed by the two entities. The retail data model follows the data processed by these entities: ProcessorsID, DistributionID, ProductName, DeliveryID, FishSpecies, ThreatmentType, PackagingType, FishNetto, FishNetto, Processing temperature, Storage temperature, and ExpiredDate.

3.2. Block chain model for traceability of capture fisheries

The model is the development of the existing supply chain and contained the data in each entity, which is a capital in the development of traceability systems. Block chain technology is used to provide security, transparency, and ease of access to the entities within it. The conceptual model of block chain technology in the supply chain of capture fisheries products shows that each entity involved in the supply chain correlates with the block chain network. The model of block chain technology on traceability of supply chain capture fisheries products is shown in Fig. 5.

Table 1. Fishermen and fish market data model.

No.	Fishermen Data Field	Fish Market Data Field
1	Vessel ID	Product_ID
2	Vessel name_	Vessel name_
3	Product_ID	Vessel ID
4	Vessel registry	Check Control
5	Capture Method	Capture Area
6	Fish Weight and Species	Capture Date
7	Treatment	Datetime Receive
8	Area	Transit ID
9	Capture Date	Fish Weight and Species
10	Datetime Delivery	Datetime Delivery
11	Transit ID	Market ID

Table 2. Processors and distribution data model.

No.	Processors Data Field	Distribution Data Field
1	ProcessorsID	Product_ID
2	DocumentProof	VehicleID
3	TransitID	ProductNetto
4	Datetime Receive	QA Control
5	ProductID	ProductionDate
6	QAControl	ProductionID
7	ColdMethod	ProcessorsID
8	Fish Weight and Species	DeliveryDatetime
9	FishNetto	DistributionTemperature
10	ProductName	StorageTemperature
11	Process Stages	DestinationID
12	Package Type	
13	Processing temperature	
14	Storage temperature	
15	productID	

The architecture developed in the block chain technology model in supply chain traceability of capture fisheries products is shown in Fig. 6. The architectural model shows the existence of three architectural layers, namely the supply chain, application, and block chain layer. Supply chain layer shows the entities contained in the supply chain of capture fisheries products to supply data that is stored in its information system / application. Application layer is a layer that contains an integrated capture fishery product supply chain information system or applications which can be used for processing data to be stored and used in the supply chain activities. Block chain layer is a layer used to store all data activities that occur in the supply chain operations of capture fisheries products, in the form of data blocks that are encrypted and controlled by utilizing the smart contract and distributed to each entity involved.

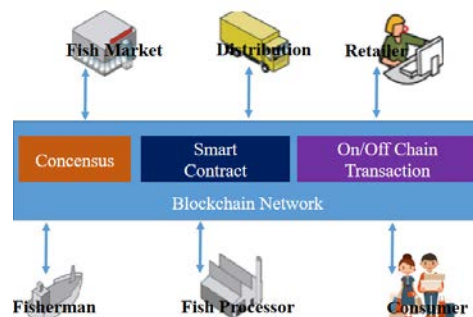


Fig. 5. Model of block chain technology in capture fisheries supply chain.

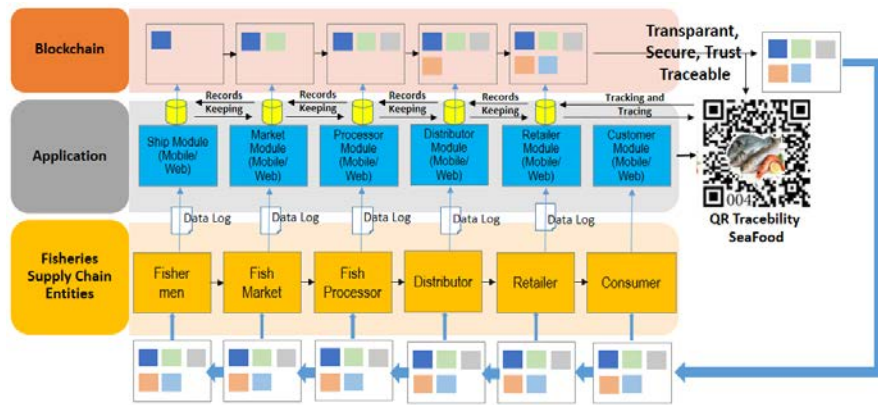


Fig. 6. Traceability of capture fisheries products based on block chain.

Each entity contained in the supply chain of capture fisheries products provides the data which is converted into block data and be used in the block chain layer. The blocks in the fishing product supply chain consist of five blocks, namely fisherman blocks (F-Blocks), Fish market blocks (M-Blocks), Processors blocks (P-Blocks), Distributor blocks (D-Blocks), and Retailer blocks (R-Block) (See Fig. 7).

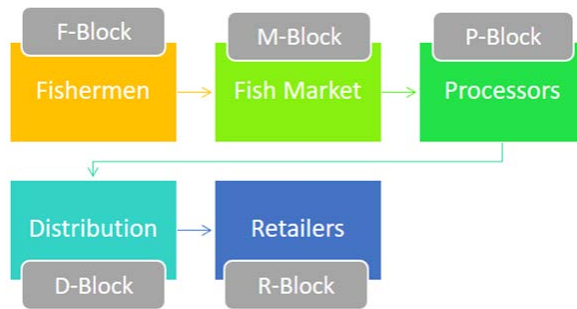


Fig. 7. Model of block flow on capture fisheries block chain.

Block data is represented in the form of data structures that represent data processed by each entity. Block data is accompanied by a hash function as a mechanism. An example is shown in Fig. 8.

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ID : F001
Block #1                                     Batch# 1
-----
Vessel Name: Citra Tuna Perkasa
Vessel ID : 2000DaNo288/N
Fishing gear : Driftnets
.....
Fishing Area: WPP RI 713
Fishing Date: 08/08/2018

Prev. Hash : abcdef0000abcd1abcdef5678abcdbb
New. Hash  : 8bc9ef5080a0affbadadfedea564844bc
    
```

Fig. 8. Block format for fishermen / ships entities.

Transactions were carried out in the supply chain operations of capture fisheries products which utilize smart contract mechanism to automate all activities involving the procedure of activities contained in each supply chain entity. Smart contracts in the supply chain of capture fisheries products are applied to the relationship between fishermen and fish market contracts, fish market and fish processor contracts, fish processor and distributor contracts, and distributor contracts with retailers. Other supporting contracts were developed to initiate block chain control contracts as well as contracts relating to financial value contained in the supply chain environment. Smart contract flow in the supply chain of capture fisheries products is shown in Fig. 9.

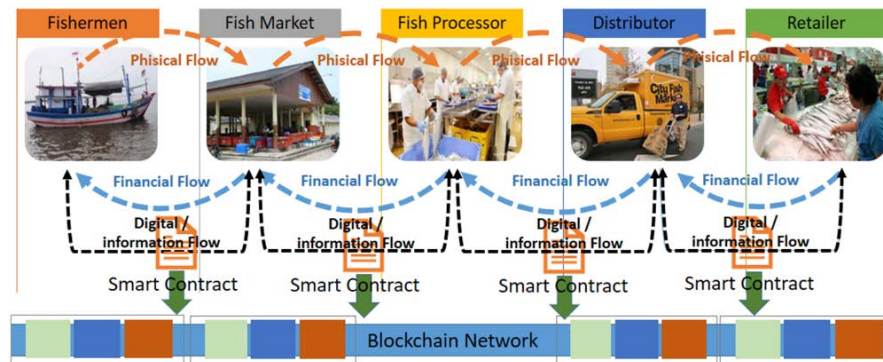


Fig. 9. Block chain smart contract model of capture fisheries.

Smart contracts used in block chain technology for traceability of capture fisheries products are developed into three types of smart contracts namely smart contract control, financial smart contracts, and smart contract operations. The control smart contract oversees the operation of financial smart contracts and operational smart contracts. The control smart contract acts as a link between the two smart contracts. Financial smart contracts are responsible for activities that involve financial transactions in the system. Meanwhile, operational smart contracts are used to automate each stage that needs to be completed in each transaction (transactions at suppliers to retailers). The development of supply chain traceability in capture fisheries in Indonesia emerge data transparency between all entities [16]. This is due to data storage on the block chain that can be accessed by all parties involved [17]. The high security mechanism on the block chain can be eliminate manipulation [19]. Therefore, it increases the trust in Indonesian capture fisheries products. The developed smart contract give rise to an automation mechanism for transactions [14] as well as in finance [17] that runs in the Indonesian capture fisheries supply chain. Therefore, the transactions can be carried out quickly and efficiently without third party [7]. The flow of information can be accessed more easily, both from upstream to downstream and vice versa for the search of its origin.

4. Conclusion

Block chain technology has the potential and ability to transform traditional business processes into faster, safer, and more precise business processes. Block chain technology is able to support the traceability of a product. Thus, it increases

the value of transparency and trust in consumers. The application of block chain technology to traceability fisheries products, it is expected that the capture rank products are able to maintain quality from upstream to downstream and provide added value to all entities involved in the supply chain of capture fisheries products.

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